Recreational Use, Social and Economic Characteristics of the Smith River and Philpott Reservoir Fisheries, Virginia

by

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(Abstract)

I used on-site interviews and angler counts to estimate angler effort, catch and harvest rates, and total catch and total harvest. On the Smith River, angling pressure per km was most intense in the special management area, with most use occurring on weekend days. Anglers harvested approximately 90% of the rainbow trout they caught, and 63% of the rainbow trout stocked during the study period. Anglers harvested only 5% of the brown trout they caught. Philpott Reservoir was overwhelmingly a nonconsumptive black bass fishery (anglers harvested only 9% of the black bass they caught). I also estimated net economic value of both fisheries using the travel cost method (TCM) and contingent valuation method (CVM). In addition to estimating net economic value for the fisheries under current fishing conditions, I also explored changes in economic value under different fishing scenarios and alternative flow regimes. On the Smith River, doubling an angler's chance of catching a large trout (>16 in.) had the highest net economic value of any scenario in all three river sections. The wild trout scenario had the highest net economic value in the special management area. On Philpott Reservoir, doubling an angler's chance of catching a black bass had the highest net economic value. Total economic value (including angler expenditures) of both fisheries was $656,140, only $13,000 less than the value of power produced at Philpott Dam during Fiscal Year 1995.

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CHAPTER 1

Angler Use, Catch and Harvest Rates, and Total Catch and Total Harvest on the Smith River and Philpott Reservoir

INTRODUCTION

Creel surveys provide fishery managers with a powerful tool which can serve a variety of purposes. Traditionally surveys have been used to meet biologically-related goals, such as determining mortality rates or population sizes. Pollock et al. (1991) developed a method of estimating natural and fishing mortality from tagging and creel survey efforts. Larson et al. (1991) used a creel survey to estimate fishing pressure and catch of black crappie on Georgia reservoirs. Creel surveys are also useful to determine the impact of newly imposed fishing regulations. Hess (1991) used a creel survey to assess the impact of daily creel limits on largemouth bass and black crappie in Georgia.

Flexibility of creel surveys appeals to those who use them as a management tool. However, with the many uses of surveys comes a variety of methodology choices. Each situation or particular water body surveyed will dictate the appropriate angler contact method. In many instances, off-site surveys such as mail, telephone, and door-to-door can be effective. However, these methods often depend on an angler's ability to recall facts (i.e., number of fish caught, size, etc.) from a fishing trip. Recall bias in off-site surveys can be a problem when the time elapsed between fishing activity and the survey is long (Brown 1991). Off-site surveys do offer benefits on-site surveys cannot, such as being less expensive and requiring less manpower to implement. On-site angler contact is usually made by a roving or access point design. In a roving creel design, a creel clerk travels the fishery looking for anglers to interview. Usually the route the clerk will travel is predetermined. Anglers finished fishing for the day are contacted in order to generate precise estimates of catch and harvest rates. However, completed trip interviews are not mandatory, and are often difficult to obtain. Malvestuto et al. (1978) verified the use of incomplete trip catch per unit effort as an unbiased estimator of complete trip catch per unit effort. Wade et al. (1991) used a computer simulation to estimate bias of catch and effort estimates from a roving creel design. They found bias was related to time needed to complete an interview, and the number of parties fishing. Bias was reduced when sampling took place on a scheduled route. However, some authors have found differences between completed and incomplete trip estimates of harvest. Phippen and Bergersen (1991) estimated significantly higher harvest estimates from incomplete trip interviews compared to estimates derived from completed trip data. Due to the potential biases associated with incomplete trip interviews, many researchers choose an access point design over a roving design when possible. Access point designs eliminate recall bias because trip information is obtained when anglers are leaving the water body. On larger water bodies, or those with limited access, access point surveys are very effective. Robson and Jones (1989) used an access point design to assess New York's Great Lakes recreational fishery. When many possible access points exist, probabilities may be assigned so those areas with heaviest use are more likely to be chosen as an interview location. Probabilities can be generated in a variety of ways. Stanovick and Nielsen (1991) used expert opinion from fishery managers to rank use at various access points along the James River, Virginia, and allocated sampling effort accordingly. Probabilities can also be generated from car counts or other methods designed to estimate use at access sites.

The Virginia Department of Game and Inland Fisheries (VDGIF) needed catch and harvest rates, total catch and total harvest, and effort estimates to determine effects of angling on the trout population in the Smith River. Data characterizing anglers, such as demographic, socioeconomic, and gear preference characteristics, will allow the VDGIF to make well informed management decisions. The opportunity to catch wild trout makes the Smith River a popular fishery for anglers throughout the region. Data were needed to estimate use of the wild trout and stocked trout fishery. The opportunity also exists to improve the current fishery through changes in flow management. Flow management alternatives need to be valued economically and compared to costs associated with those management options. Costs also will be associated with flow regimes designed to improve the trout fishery. Current generation patterns allow for electricity to be produced efficiently. Changes in flow patterns may reduce efficiency of electrical energy production. Public input is needed regarding current management of the river and areas VDGIF should concentrate on in the future (e.g., increased access, stocking, regulations). Economic analyses are needed to estimate the net economic value of the Smith River trout fishery, values of different management options, and the value anglers place on various fishing conditions, such as catching larger fish versus more fish.

The VDGIF is currently attempting to assess the population of a variety of species found in Philpott Reservoir. These species include largemouth bass (*Micropterus salmoides*), smallmouth bass (*Micropterus dolomieu*), crappie (*Poxomis nigromaculatus*), channel catfish (*Ictalurus punctatus*), walleye (*Stizostedion vitreum*), brown trout (*Salmo trutta*), and rainbow trout (*Oncorhynchus mykiss).* Bass, trout and walleye have been stocked in the reservoir but the VDGIF has no solid evidence showing how or if trout and walleye contribute to the overall fishery. It is not known if a fishery exists for trout specifically, or if trout caught are a bycatch of fishing efforts directed toward other species. Fishery managers suspected that a walleye fishery existed in the upper Smith River and Runnet Bag Creek arms of Philpott Reservoir during the spring spawning period.

However, walleye angler success has not been determined. The VDGIF also needed estimates of angler and nonangler use, catch rates, and angler characteristics. Whitehurst (1981) estimated angler use to be 62,839 hours from March through December, 1980. Catch rate for black bass was .11 fish/hr. He reported 57% of angler effort was directed toward black bass. Black crappie and channel catfish were the third and fourth most sought after fishes, respectively. Estimates of current use and catch and harvest were also needed to estimate the impact of angling on the Philpott Reservoir fishery. Angler attitudes toward current management practices and direction of future VDGIF management efforts also needed to be assessed. This information will help VDGIF identify management areas which need to be addressed (e.g., increased access, law enforcement). Economic benefit of the current fishery and alternative management options also needed to be estimated so that relative importance of recreational opportunities could be compared.

Research Objectives

This thesis addresses the following research objectives:

1. To estimate angler use, catch and harvest rates, total catch and total harvest in three sections of the Smith River between Philpott Dam and the community of Kohler between March 1, 1995 and December 31, 1995.

2. To describe demographic, socioeconomic and gear preference characteristics of anglers using the Smith River and their attitudes towards various management alternatives.

3. To estimate the economic value of the Smith River fishery and the economic tradeoffs associated with alternative flow regimes.

4. To estimate angler use, catch and harvest rates, total catch and total harvest by species in two sections of the reservoir and upper Smith River between February 15, 1995 and November 30, 1995.

5. To describe demographic and socioeconomic characteristics of anglers using Philpott Reservoir.

6. To estimate the economic value of the Philpott Reservoir fishery and economic tradeoffs associated with alternative management strategies.

Smith River

Study Area Description

The coldwater fishery of the Smith River extends approximately 22.9 km downstream from Philpott Dam. The VDGIF stocks rainbow trout throughout the year in two sections of the river, one upstream and one downstream of a special regulations section. No fish are stocked in the special regulations section. Rainbow trout is the only species stocked, as of 1977, due to a naturally reproducing brown trout population, and the desire to keep the fishery wild. The special regulations section differs from other parts of the river in that only single-hook artificial lures may be used, only one fish may be kept, and in a larger minimum size limit of 16 inches. Regulations on the rest of the river are 6 fish per day with a minimum size limit of 10 inches.

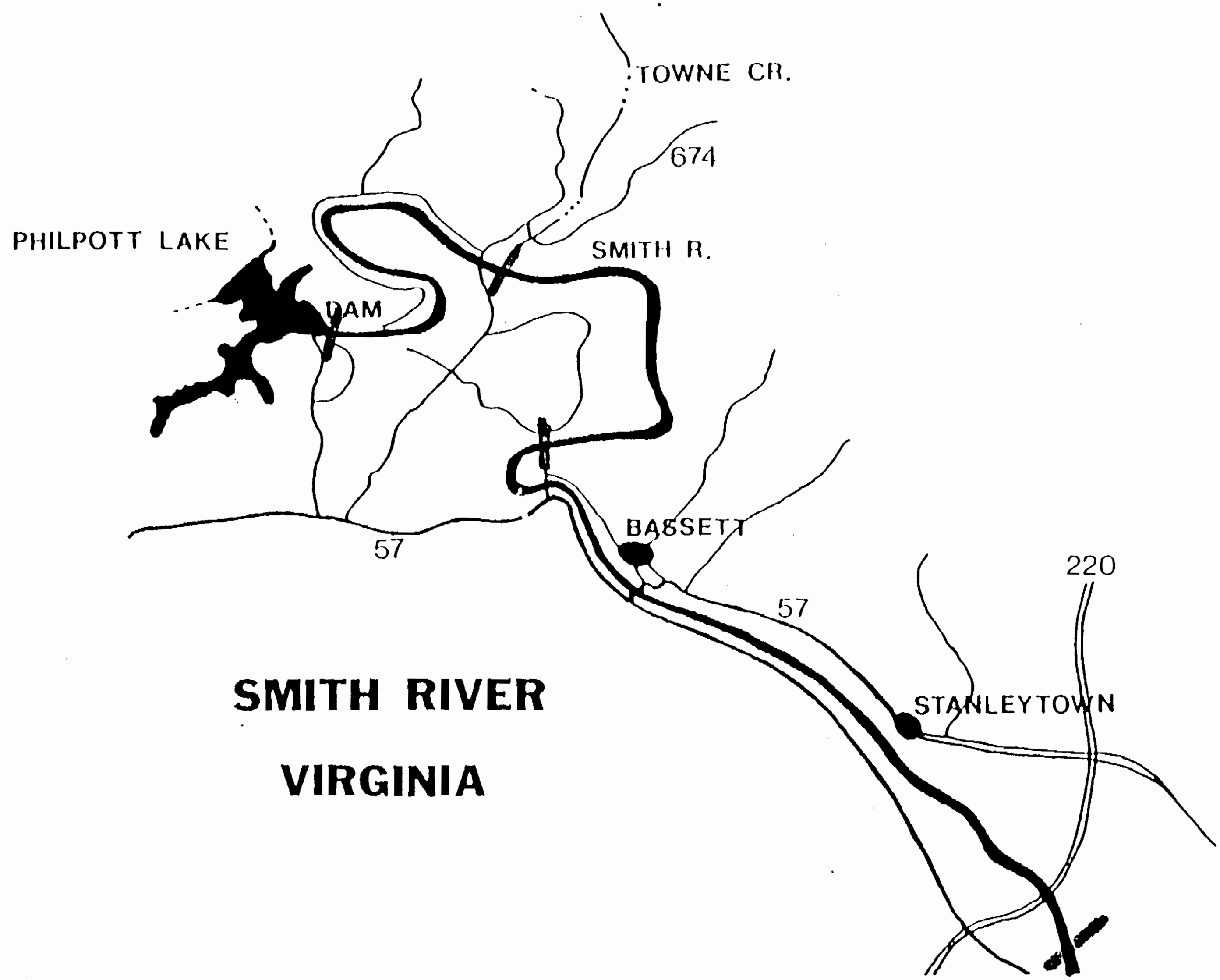
Fishing regulations are not the only factors differentiating the special regulations section from reaches above and below it. I expected anglers within this section to differ from anglers in the other sections socioeconomically, demographically, and in their motivation for fishing. I expected anglers in the special regulations section to be more likely to fish for enjoyment, to be in the outdoors, or to test their fishing skills, whereas anglers in the other sections were expected to fish for food or to catch a bag limit of fish, factors not as important to anglers in the special regulations section.

Physical characteristics of the river also change as it flows downstream. In the upper reach near the dam and extending through the special regulations section, stream banks remain in a relatively natural state, with abundant riparian vegetation. The downstream portion of the special regulations section is channelized and characterizes a change in the environment surrounding the river. Beginning at the downstream end of the special regulations section, furniture and textile industries occupy much of the river banks and little of the river remains in a natural state.

I divided the Smith River into three sections. The first section extended downstream from Philpott Dam to the mouth of Town Creek, a distance of 5.3 km (Figure 1). There are no gear restrictions in this section or the lower section. The middle section extends downstream from the mouth of Town Creek to the Route 666 bridge in Bassett, Virginia, a distance of 3.3 km. The lower section extends downstream from the Route 666 bridge to the Memorial Baptist Church in Kohler, Virginia, a distance of 14.3 km.

The U.S. Army Corps of Engineers (USCOE) constructed Philpott Dam as a hydroelectric and flood control facility in 1953. The powerhouse contains three generators (combined capacity of 14,000 kw) operated in a peaking mode by the USCOE. One generator, smaller than the other two, operates constantly providing a minimum flow of approximately 1.5 cubic meters/second (cms) in the river. Peaking mode operation results in power generation corresponding to demand for electrical energy. American Electric notifies the USCOE when electricity is needed. During peak generation periods, flows are greater than 34 cms. Periods of generation result in vertical water level increases of approximately 1 m (Smith 1992). Minimum flows in the Smith River are substantially lower than optimum levels of 7-10 cms as assessed by the U.S. Fish and Wildlife Service (USFWS) using the instream flow incremental methodology (USFWS 1986). River flows decrease downstream as industry and municipality-related water intakes further deplete river flow. Peaking mode generation also influences when and where anglers fish

Figure 1. Smith River below Philpott Dam. The tick marks denote the upper, middle and lower sections extending downstream from the dam.



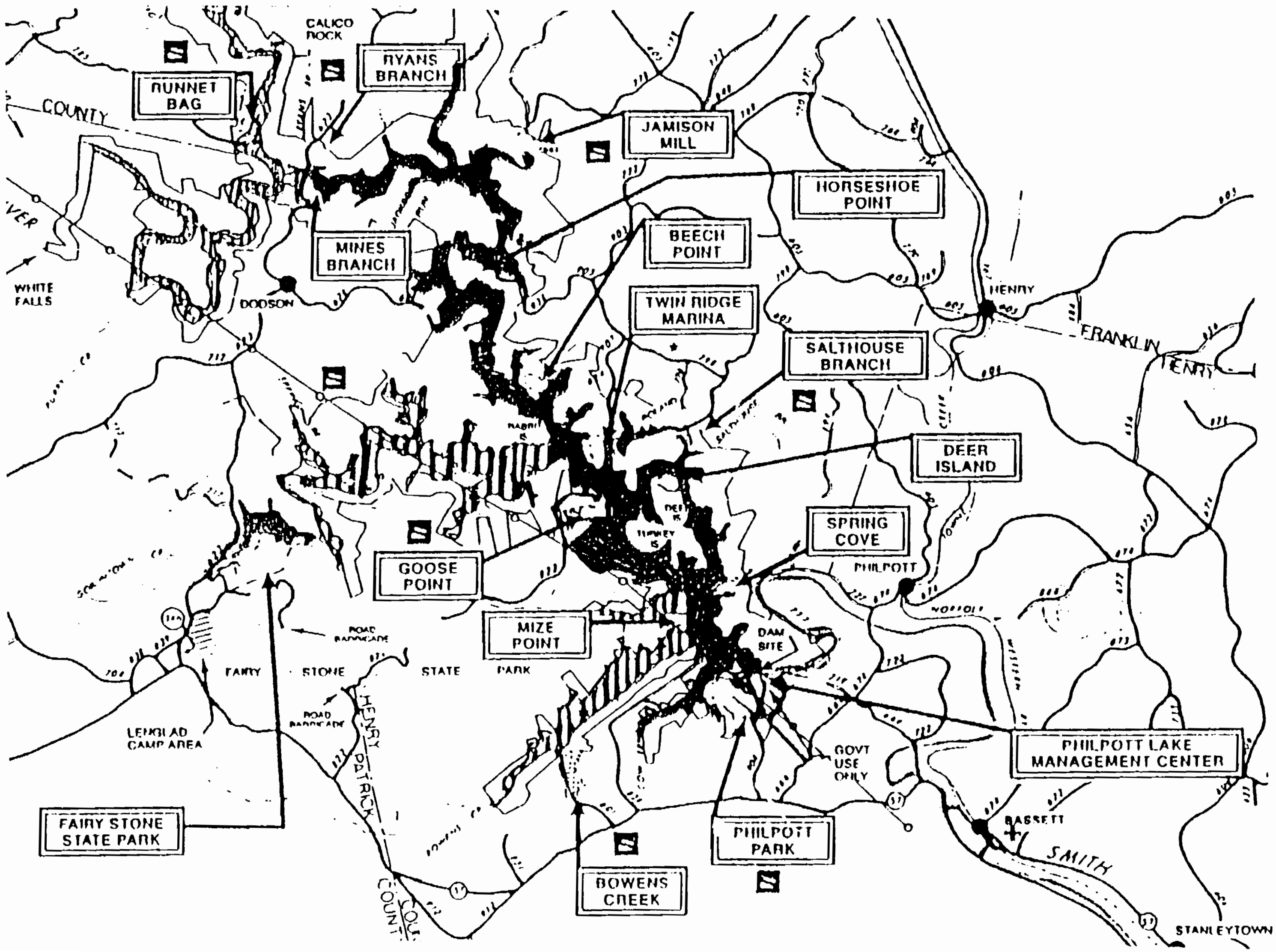
the Smith River. Almost all generating occurs during the week, which may make the river a weekend only fishery for many anglers, especially those investing substantial time and money traveling to the Smith River. Anglers are not prohibited from fishing during generation, however fishing conditions are difficult, especially for wading anglers.

Philpott Reservoir

Construction of Philpott Dam began in 1948 and was fully completed in 1953. The dam impounded the Smith River and several smaller streams. Mean surface elevation fluctuates between 323 to 324.5 m above sea level depending on time of year. Philpott Reservoir is approximately 1,166 ha. in size and is moderately dendritic. Mean depth is 18.3 m, and maximum depth is 58.3 m at the dam (Duval 1990). Shoreline development is minimal due to USCOE property ownership. The pristine appearance is a characteristic that may attract many users. Philpott Reservoir is popular with recreational boaters, water skiers, jet skiers, sailboaters, and anglers. Warmwater species (largemouth bass, smallmouth bass), coolwater species (stocked walleye), and coldwater species (stocked brown and rainbow trout) all are found in the reservoir.

I established three sections in the reservoir so that instantaneous counts (< 1 hr) could be completed (Pollock et al. 1994). The upper section extended from Union Creek Bridge up both the Runnet Bag Creek (4 km) and Smith River arms (6.4 km; Figure 2). The middle section (8.9 km) is more riverine than the lower section and extends from the northernmost point at the mouth of the Goblintown Creek arm to the Union Creek bridge (Figure 2). The lower section is shorter and broader than the middle section and is characterized by two large islands, Deer and Turkey. The lower section extends from the northern point of the Goblintown Creek arm to Philpott Dam (Figure 2).

Figure 2. Philpott Reservoir showing study sections, interview locations and count start locations.



METHODS

Smith River

Estimating Angler Use

I stratified estimates of angler use by river section, season, and day type (weekdays and weekend days). The spring season extended from March 1 through May 24 in the middle section and from March 18 (opening day of trout season) through May 24 in the upper and lower sections. The summer season extended from May 25 through September 4 for all sections. September 5 through December 17 comprised the fall season for all sections. I randomly chose sampling days from all available weekdays or weekend days in a season. Holidays were treated as weekend days. Selection of sample days was constrained by two rules. First, a single section would not be sampled on two consecutive weekend days, and second, no more than seven days would pass without sampling any section. At the outset of the project, two weekend days and two weekdays were sampled in each section per month, for a total of 12 days sampled each month. After the spring season, I scheduled additional sample days in each section. The upper and middle sections received the majority of additional sampling days because angler interviews were more easily obtained in these sections.

I worked one-half of each sample day. The morning period began at sunrise and ended at the midpoint of daylight hours. The evening period extended from mid-day to sunset. I chose the period worked each day randomly with both the morning and evening period having 0.50 probabilities of being selected.

Conducting angler counts

I made three instantaneous angler counts each sampling day. In the upper section, counts were completed by driving a road adjacent to the river and counting anglers. If a car was spotted but no angler was observed in the river, I walked down the river bank until the angler(s) were found. To count the upper portion of the middle section, I walked along the river, looking through the brush for anglers. The lower part of the middle section could be observed by looking upstream from the Route 666 bridge in Bassett. The lower section was the most problematic with regards to angler counts. Due to development along the river, it was difficult to tell if parked cars belonged to anglers. Much of the river was not visible from the road. I traveled a standard route that crossed the river at numerous bridges, affording views in both upstream and downstream directions. I used binoculars as an aid to count anglers in the lower section.

Count start times were randomly chosen within morning or evening periods, except that start times had to be at least 30 minutes after completion of previous counts. The direction of the count, upstream or downstream, was also determined randomly.

Opening weekend of trout season

I estimated angler effort separately in all three river sections for the opening day of trout season (March 18). A crew of four VDGIF personnel set up a check station at the main entrance/exit to the upper section, counting and interviewing anglers as they left. A creel clerk in the middle section conducted five angler counts throughout the day. The lower section, due to its length, was sampled by two creel clerks, with each clerk making five counts in each half of the section. All three sections were sampled from 6:00 a.m. to 6:00 p.m. The lower section was also sampled on March 19, and due to unusually high angler counts, was included with the opening day analysis.

Calculating angler use (effort)

I estimated angler effort for each river section and day type within each season using procedures described in Pollock et al. (1994). To expand count data to angler effort, I averaged the three angler counts conducted each day. If only two counts were made (e.g., due to bad weather) the two counts were averaged. However, if only one count was made, I did not estimate angler effort that day. After averaging the counts, I multiplied the mean by total day length to yield a daily effort estimate. I then multiplied mean daily effort by the total days in the season to determine total effort (Equation 1.1).

$$\hat{E} = (\bar{\hat{e}})(N) \qquad \text{(Equation 1.1)}$$

where:

$\hat{E}$ = total estimated effort

$(\bar{\hat{e}})$ = mean of daily effort estimates

N = total number of days in a season (section and day type specific)

Calculation of the confidence interval about the point estimate of effort was a five-step process. First, I calculated variance of the weekday or weekend day block effort using Equation 1.2 (Pollock et al., 1994).

$$\hat{Var}(\hat{e}_{wd,we}) = \frac{1}{n-1}\sum_{i=1}^{n}\left(e_i - \bar{e}\right)^2 \qquad \text{(Equation 1.2)}$$

where:

$\hat{Var}(\hat{e}_{wd,we})$ = variance of weekdays or weekend days (section and season specific) n = total number of weekdays or weekend days sampled in a season

e = daily effort estimate for a given weekday or weekend day

$\bar{e}$ = mean of daily effort estimates for weekdays or weekend days

I then divided the variance of weekday or weekend day effort by the number of days sampled in the season to obtain a daily variance estimate within the block (Equation 1.3).

$$\hat{Var}(\bar{e}_{wd,we}) = \frac{Var(\hat{e}_{wd,we})}{n} \quad \text{(Equation 1.3)}$$

where:

$\hat{Var}(\bar{e}_{wd,we})$ = daily variance estimate

The daily variance estimate was then expanded to variance for the sampling season (Equation 1.4).

$$\hat{Var}(\hat{E}_{wd,we}) = N^2 Var(\bar{e}_{wd,we}) \quad \text{(Equation 1.4)}$$

where:

$\hat{Var}(\hat{E}_{wd,we})$ = season variance for weekdays or weekend days

Standard error of season effort was calculated as the square root of the variance of $\hat{E}$ (Equation 1.5).

$$S\hat{E}(\hat{E}_{wd,we}) = \sqrt{\hat{Var}(\hat{E})} \quad \text{(Equation 1.5)}$$

where:

$S\hat{E}(\hat{E}_{wd,we})$ = standard error of the total effort point estimate

I used equation 1.6 to construct the confidence interval.

$$80\%\ CI = \hat{E} \pm (S\hat{E}(\hat{E}_{wd,we}))(t_{0.1,\ n-1}) \qquad \text{(Equation 1.6)}$$

Estimating Catch and Harvest Rates

Catch rate

I estimated catch rates for brown trout and rainbow trout separately, for each river section, season, day type, and size class. The three size classes for which catch rates were estimated were < 10 in., 10-16 in., and > 16 in. Separate catch rates were estimated for opening weekend. Fish kept by anglers were measured to the nearest 1 mm. I asked anglers to estimate the size of released fish (< 10 in., 10-16 in., > 16 in.). Only those anglers who had completed their trip were interviewed at the outset of sampling. To increase the number of interviews, I began to incorporate incomplete trip interviews after the first two months of the study.

I estimated catch rate by dividing the mean number of fish caught, for a specific river section, season, species, and day type, by the average total time spent fishing (Equation 1.7). This is the method recommended by Pollock et al. (1994) for estimating catch rate based on complete trip interviews. Total time spent fishing was equal to the product of total number of anglers in a party multiplied by time spent fishing.

$$\hat{R}_1 = \frac{\sum_{i=1}^{n} c_i / n}{\sum_{i=1}^{n} L_i / n} = \bar{c} / \bar{L} \qquad \text{(Equation 1.7)}$$

where:

$\hat{R}$ = estimated catch rate for population

c = mean number of fish caught

L = mean length of trip at time of interview

n = sum of all anglers per trip

Harvest rate

I calculated harvest rate in the same manner as catch rate, except that only fish caught and kept were used to calculate the numerator (Equation 1.8).

$$H\hat{R} = \frac{\sum_{i=1}^{n} h_i / n}{\sum_{i=1}^{n} L_i / n} = \bar{h} / \bar{L} \qquad \text{(Equation 1.8)}$$

where:

$H\hat{R}$ = harvest rate for population

$\bar{h}$ = mean number of fish harvested

$\bar{L}$ = mean length of trip at time of interview

n = sum of all anglers per trip

Estimating Total Catch and Total Harvest

Total catch

I estimated daily catch as the product of daily catch rate (Equation 1.7) and daily effort (mean of angler counts times total day length). Mean daily catch multiplied by total number of weekdays or weekend days in a season yielded an estimate of total catch (Equation 1.9). I estimated total catch for each trout species, river section, season, day type, and size class.

$$\hat{C}_{wd,we} = (N_{wd,we})(\bar{\hat{C}}_{wd,we}) \qquad \text{(Equation 1.9)}$$

where:

$\hat{C}_{wd,we}$ = total catch estimate for weekdays or weekend days for the population

$N_{wd,we}$ = number of weekdays or weekend days in a season

$\bar{\hat{C}}_{wd,we}$ = mean of daily catch estimates

The confidence interval about the point estimate of total catch was calculated through a five-step process similar to that described above (Equations 1.10 through 1.14). First, variance of daily catch estimates was calculated (Equation 1.10).

$$Var(\hat{c}_{wd,we}) = \frac{1}{n-1}\sum_{i=1}^{n}\left(\hat{c}_i - \bar{c}_i\right)^2 \qquad \text{(Equation 1.10)}$$

where:

$Var(\hat{c}_{wd,we})$ = variance of weekday or weekend daily catch estimates

n = number of days sampled in a season (day type specific)

$\hat{c}$ = daily catch estimate for a given day

$\bar{c}$ = mean of daily catch estimates

Variance of daily catch was divided by the number of days sampled in a season to yield an estimate of mean daily catch variance (Equation 1.11)

$$\hat{Var}(\bar{c}_{wd,we}) = \frac{Var(\hat{c}_{wd,we})}{n} \qquad \text{(Equation 1.11)}$$

where:

$\hat{Var}(\bar{c}_{wd,we})$ = variance of mean catch for weekdays or weekend days

I then expanded the variance of mean catch to estimate a variance for the entire season (Equation 1.12).

$$\hat{Var}(\hat{C}_{wd,we}) = N^2 Var(\bar{c}) \qquad \text{(Equation 1.12)}$$

where:

$\hat{Var}(\hat{C}_{wd,we})$ = sample season variance for weekdays or weekend days

Standard error was calculated as the square root of sample season variance (Equation 1.13)

$$\hat{SE}(\hat{C}) = \sqrt{\hat{Var}(\hat{C})} \qquad \text{(Equation 1.13)}$$

where:

$\hat{SE}(\hat{C})$ = standard error of the total catch point estimate

Equation 1.14 was used to construct the confidence interval.

$$80\%\ CI = \hat{C} \pm (\hat{SE}(\hat{C}))(t_{0.1,n-1}) \qquad \text{(Equation 1.14)}$$

Total harvest

I estimated total harvest in the same manner as total catch, except daily harvest rates (Equation 1.8) were used to calculate daily harvest estimates. I estimated total harvest for both trout species, river section, season, day type, and size class (Equation 1.15).

$$\hat{H}_{wd,we} = (N_{wd,we})(\overline{H}_{wd,we}) \qquad \text{(Equation 1.15)}$$

where:

$\hat{H}_{wd,we}$ = total harvest estimate for the population

$N_{wd,we}$ = total number of days of a specific day type in a sampling season

$\overline{H}_{wd,we}$ = mean of daily harvest estimates

Confidence intervals about total harvest estimates were done in the same manner as those for total catch, except that daily harvest was substituted for daily catch (Equations 1.16 through 1.20).

$$\mathrm{Var}(\hat{h}_{wd,we}) = \frac{1}{n-1}\sum_{i=1}^{n}\left(\hat{h}_i - \overline{h}_i\right)^2 \qquad \text{(Equation 1.16)}$$

where:

$Var(\hat{h}_{wd,we})$ = variance of weekday or weekend daily harvest estimates

n = number of weekday or weekend days sampled in a season

$\hat{h}$ = daily harvest estimate for a given weekday or weekend day

$\bar{h}$ = mean of daily harvest estimates

$$V\hat{a}r(\bar{h}_{wd,we}) = \frac{Var(h_{wd,we})}{n} \quad \text{(Equation 1.17)}$$

where:

$V\hat{a}r(\bar{h}_{wd,we})$ = daily variance estimate for weekdays or weekend days

$$V\hat{a}r(\hat{H}_{wd,we}) = N^2 Var(\bar{h}) \quad \text{(Equation 1.18)}$$

where:

$V\hat{a}r(\hat{H}_{wd,we})$ = sample season variance for weekdays or weekend days

I used the variance estimate for the sampling season to calculate a standard error (Equation 1.19)

$$S\hat{E}(\hat{H}) = \sqrt{V\hat{a}r(\hat{H})} \quad \text{(Equation 1.19)}$$

where:

$S\hat{E}(\hat{H})$ = standard error of the point estimate of total harvest

$$80\%\ CI = \hat{H} \pm (S\hat{E}(\hat{H}))(t_{0.1,n-1}) \quad \text{(Equation 1.20)}$$

Philpott Reservoir

Estimating Recreational Use

I estimated recreational use by boat anglers, bank anglers, pleasure boaters, and personal watercraft users (jet ski, sea doo). Although angler use was of most interest, it was not difficult to count the other primary users at the same time. Inclusion of other users allowed for investigation of angler use patterns as they were influenced by other users. All user groups were counted during each of three counts scheduled each sampling day.

Conducting user group counts

The spring season on Philpott Reservoir occurred from February 1 through May 24 for the lower and middle sections, and from February 1 through May 1 for the upper section. The upper section was sampled only through May 1 because heavy use was anticipated in this section during the walleye spawning season. After this time, use in this section was not heavy enough to warrant additional sampling. The summer season extended from May 25 through September 4 for both sections. The fall season began on September 5 and ended on November 31.

During the period when all three sections were being sampled (February through April), two weekdays and two weekend days were sampled in each section per month. After sampling in the upper section ceased, additional sample days were added in the lower two sections. Four weekdays and three weekend days were sampled in the lower two sections each month from May through November.

In the lower two sections, I used an 18-ft boat with a 175 hp outboard motor to conduct user group counts. Due to shallow water in the upper section, I used a smaller 16-ft foot john boat with a 25 hp outboard. Pleasure boating and personal watercraft were not allowed above Union Creek Bridge and therefore only anglers were counted in the upper section. I counted anglers in each arm as far upstream as water depth allowed. The starting point for counts was at the top of one arm and ended at the top of the opposite arm, counting anglers only on the way into or out of the arm, but not both ways. I randomly determined the arm in which the counts began.

The middle section of the reservoir was narrow enough to count users off both sides of the boat, counting only on the way up or down. Due to the larger expanse of open water, counts in the lower section were slightly more problematic. I drove approximately 200 yards off one shoreline and counted users between the boat and shore, and between the boat and a point approximately in the middle of the main reservoir. When on the opposite shore, I counted from boat to shore again, and from the boat to a point in the middle of the main reservoir, using binoculars to avoid double counting.

I randomly determined count start times, start location, and direction of travel. A pool of four sites served as possible count start locations in the middle section, while the lower section had seven sites (Figure 2). The count start locations in the lower section were spread evenly throughout the section while those in the middle section were at the top and bottom of the section.

I also estimated angler effort for regularly scheduled Monday (7:00 p.m.-11:00 p.m.) and Friday (7:00 p.m.-1:00 a.m.) night bass tournaments, which were held between April 28 and October 27, by multiplying the mean number of Mondays and Fridays that fell between April 28 and October 27 by the mean number of boats per tournament (2 anglers/boat). I then multiplied that product by four and six hours to account for tournament length for Mondays and Fridays, respectively. Additionally, larger tournaments were held on Philpott Reservoir and use at these events was included in the total tournament use estimate. Larger tournaments, with substantial cash prizes, required a permit from VDGIF and also required the permittee to supply VDGIF information regarding the number of fish caught and number of boats in the tournament. I used the number of boats (2 anglers/boat) multiplied by the length of the tournament to estimate use for the larger tournaments.

Calculating recreational use

I estimated recreational use of Philpott Reservoir for each of the designated user groups in each season, reservoir section, and day type. Tournament angler effort was estimated separately from nontournament anglers. I estimated angler and user effort, and 80% confidence intervals using the same equations and steps described in the "Estimating Angler Effort" section for the Smith River (Equations 1.1, 1.2, 1.3, 1.4, 1.5, and 1.6).

I used the time between scheduled counts to conduct interviews at randomly selected boat ramps. Due to the time required to conduct three counts during the half-day sample period, time spent interviewing anglers was limited. Bank angler interviews were limited to the various campgrounds. I also obtained interviews at night throughout the summer, when many anglers fished to avoid heavy recreational use during daylight hours. I approached tournament anglers at the weigh-in site, asking all questions on the interview form unless they had been previously interviewed, in which case I asked only about their catch (Figure 3).

Estimating Catch and Harvest rates

I estimated catch and harvest rates for brown trout, rainbow trout, walleye, black bass (largemouth bass and smallmouth bass), sunfish species, crappie and catfish. Black bass catch rates were estimated for the following three size classes: < 12 in., 12-15 in., and > 15 in. I analyzed catch rates for tournament anglers separately from nontournament anglers.

Figure 3. Interview form used for tournament anglers who were previously interviewed.

Philpott Reservoir
Bass Tournament Form

Please fill in the following information regarding the tournament in which you are fishing. **The information should be for you only, not for the boat.**

Date:________ Tournament sponsor name:______________

Launch time:________ Weigh-in time:_________

Please fill in the total number of largemouth and smallmouth bass you caught, and number in each size category. This includes fish culled, or released before weigh-in.

Largemouth

Total number largemouth caught:__________

<12in_____ 12-15in____ >15in_____

<12in_____ 12-15in____ >15in_____

Smallmouth

Total number of smallmouth caught:_______

<12in_____ 12-15in______ >15in_______

<12in_____ 12-15in______ >15in_______

The next few items will allow us to characterize bass tournament anglers who fish Philpott. Please fill in the following information.

Sex (circle): male female

Place of residence: county________ state_____

Age:_____

This information will be used, along with that of the creel survey on Philpott, to estimate recreational use (angler hours), catch rates, and economic value of the Philpott fishery. Thank you for assisting with our efforts.

Virginia Department of Game and Inland Fisheries.

I conducted on-site interviews at USCOE campgrounds and boat ramps around the reservoir (Figure 2), obtaining the following information: total number of fish caught by species, number of fish caught and kept by species, length of released fish (estimated size class of released fish), species sought, number of anglers in party, and time spent fishing, all of which I used to estimate catch rates. I used car count data provided by the USCOE to determine which access points received highest use. Using this information, I chose seven boat ramps as interview locations based on the percentage of total use each site received. Table 1 shows the seven interview locations and their corresponding percent of total use. The interview location did not always fall in the section being counted.

Catch rate

I estimated catch rate for each fish species and size class using steps described in the "Catch rate" section for the Smith River (Equation 1.7).

Harvest rate

I estimated harvest rate for each fish species. Black bass harvest was too low to estimate by size class. Harvest rates were calculated using the steps described in the "Harvest rate" section for the Smith River (Equation 1.8).

Estimating Total Catch and Total Harvest

Total catch

I estimated total catch and 80% confidence intervals for each fish species, including size classes for black bass, season, and day type, analyzing catch by tournament anglers separately (Equations 1.9, 1.10-1.14).

Table 1. Seven interview locations with percent of total use, derived from USCOE car count data.

Interview location	Percent of total use
Goose Point	11.2
Philpott Park	38.4
Salthouse Branch	18.6
Twin Ridge Marina	5.9
Bowen's Creek	8.8
Horseshoe Point	2.9
Ryan's Branch	14.2

Total harvest

I estimated total harvest and 80% confidence intervals for each fish species, but not for black bass size classes or tournament anglers because so few black bass were harvested (Equations 1.8, 1.9).

RESULTS

Smith River

Angler Effort Estimates

Seasonal effort estimates

On weekdays in the spring season, angler effort was highest in the upper section at 5,161 angler-hours (80% CI=689-9,633), and lowest in the middle section at 53 angler-hours (80% CI=0-134; Table 2). Effort in the middle section was considerably higher on weekend days (1,724 angler-hours, 80% CI=929-2,519) than on weekdays (Table 2). Effort on weekend days in the upper and lower sections was lower than weekday effort. I estimated total angler effort in the lower section at 7,500 angler-hours. Total angler effort, including both day types and all three river sections, was an estimated 17,489 angler-hours. Weekday effort accounted for 55% of total effort, while weekend day effort accounted for 45% (Table 2).

Angler effort during the summer season was low in the middle section on weekdays (52 angler-hours, 80% CI=0-117), accounting for only 2% of total summer season effort in the middle section (Table 3). Seventy-six percent of all weekday effort occurred in the upper section (2,133 angler-hours, 80% CI=1,343-2,924). Angler effort on weekend days was nearly equal in all three river sections (2,149 angler-hours in the upper section, 2,265 angler-hours in the middle section, 2,091 angler-hours in the lower section; Table 3). Overall, 70% (6,505 of 9,316 angler hours) of total angler effort was expended on weekend days. Total angler effort in summer season (9,316 angler-hours) was 52% less than total angler effort in the spring season.

Table 2. Angler effort estimates (angler-hours) and 80% confidence intervals for each river section during the spring season.

River section	Day type				Total
	Weekday	80% CI	Weekend	80% CI	
Upper	5,161	689-9,633	3,051	376-5,726	8,212
Middle	53	0-134	1,724	929-2,519	1,777
Lower	4,472	2,428-6,517	3,028	2,332-3,724	7,500
Total	9,686	—	7,803	—	17,489

Table 3. Angler effort estimates (angler-hours) and 80% confidence intervals for each river section during the summer season.

	Day type				
River section	Weekday	80% CI	Weekend	80% CI	Total
Upper	2,133	1,343-2,924	2,149	1,569-2,729	4,282
Middle	52	0-117	2,265	1,321-3,209	2,317
Lower	625	132-119	2,091	1,394-2,789	2,717
Total	2,810	——	6,505	——	9,316

Effort on weekdays during the fall season in the lower section (862 angler-hours, 80% CI=210-1,514), was slightly higher than the nearly equal estimates of effort in the upper section (659 angler-hours, 80% CI=307-1,011) and middle sections (657 angler-hours, 80% CI=218-1095; Table 4). The pattern of angler effort in the middle section was highest on weekend days (1,424 angler-hours, 80% CI=1,127-1,721), similar to that in the summer. Weekday effort for the fall season was considerably higher than in either spring or summer (Tables 2, 3, 4). Greatest effort for any section on weekend days during the fall season occurred in the lower section. Weekend days accounted for 62% (3,539 of 5,717 angler-hours) of total estimated fall effort.

The upper section received highest combined seasonal use on weekdays (7,953 angler-hours), followed by the lower section (5,960 angler-hours) and middle section (762 angler-hours; Table 5). Weekend day effort (5,413 angler-hours) accounted for 88% of total estimated effort in the middle section. Effort on weekend days in the upper and lower sections was similar to weekday effort estimates. Overall, effort on weekend days accounted for 56% of total estimated effort for the entire river, not including opening weekend estimates (Table 5). Total estimated effort, including opening weekend of trout season, for the entire river was 35,846 angler-hours. (Table 5).

The upper section had the highest concentration of effort of any section with 2,623 angler-hours/km (Table 6). Weekend day effort in the middle section was 1,640 angler-hours/km, highest of any section. Although the lower section had the second highest total effort estimate, effort per km was lowest (871 angler-hours/km) of any river section (Table 6).

Influence of flows on use patterns

To determine possible influence of flows on use patterns, I estimated effort for each half-day sample period in which generating occurred during at least some point,

Table 4. Angler effort estimates (angler-hours) and 80% confidence intervals for each river section during the fall season.

River section	Day type				Total
	Weekday	80% CI	Weekend	80% CI	
Upper	659	307-1,011	747	456-1,037	1,406
Middle	657	218-1,095	1,424	1,127-1,721	2,081
Lower	862	210-1,514	1,368	255-2,482	2,230
Total	2,178	—	3,539	—	5,717

Table 5. Total effort estimates (angler-hours) for each river section, including spring, summer, fall, and opening weekend of trout season.

River section	Day type		River section total	Opening weekend	Total
	Weekday	Weekend			
Upper	7,953	5,947	13,900	516[a]	14,416
Middle	762	5,413	6,175	134[a]	6,309
Lower	5,960	6,487	12,447	2,674	15,121
Total	14,675	18,184	32,522	3,324	35,846

[a]the upper and middle sections were not sampled on March 19.

Table 6. Total angler effort (angler-hours) for each river section standardized by river section length (km). Estimates include spring, summer, and fall seasons.

River section	Section length (km)	Day type		Total
		Weekdays	Weekend days	
Upper	5.3	1,501	1,122	2,623
Middle	3.3	231	1,640	1,871
Lower	14.3	417	454	871

and for half-days on which it did not (Table 7). I did not expand effort estimates to cover a full day or the sample season. They only reflect the sum of half-day effort estimates on days which were sampled. In the upper and middle sections, effort was higher on days when generating did not occur, compared to days on which it did (Table 7). The greatest difference in effort occurred in the middle section. On days when generating occurred, only one angler (accounting for 0.4 angler-hours) was counted in the middle section throughout the study, lower than the estimated 3 angler-hours when generating did not occur. In the upper section angler effort was approximately 70% higher on days when generating did not occur (Table 7).

Angler effort on opening weekend of trout season

Angler effort on opening day was highest in the lower section (2,102 angler-hours, 80% CI=1,594-2,611), followed by the upper section (517 angler-hours) and middle section (134 angler hours, 80% CI=61-208; Table 8). However, effort estimates per km did not follow the same pattern (upper=147 angler-hours/km; middle=98 angler-hours/km; lower=41 angler-hours/km). Nearly all anglers who fished in the upper section were interviewed and therefore the sample was treated as a census. Overall angler effort on opening weekend of trout season was at least 3,324 angler-hours (the upper and middle sections were not sampled on Sunday, March 19).

Catch Rate Estimates

Mean daily catch rate did not differ in any river section for complete and incomplete trip interviews (t-test, $p>0.05$ for all three river sections; Table 9). In addition, an F-test showed variance of daily catch rate estimates based on complete trip and incomplete trip interviews were not significantly different within any river section ($p> 0.05$

Table 7. Effort estimates (angler-hours) during sample days when generating occurred. Estimates are standardized to represent effort/half-day period. Numbers in parentheses are number of sampling days.

River section	Generating	Not generating
Upper	13 (13)	22 (13)
Middle	0.4[a] (5)	3 (15)
Lower	13 (11)	13 (7)
Total	11 (29)	12 (35)

[a]only one angler was counted in the middle section during generation

Table 8. Effort estimates (angler-hours) and 80% confidence intervals for each river section during opening weekend of trout season (March 18-19).

	Date				
River section	March 18	80% CI	March 19	80% CI	Total
Upper[a]	517	—	—	—	516
Middle	134	61-208	—	—	134
Lower[b]	2,102	1,594-2,611	572	445-699	2,674
Total	2,753	—	572	—	3,324

[a]all anglers fishing in the upper section were interviewed and therefore the sample is treated as a census
[b]only the lower section was sampled on March 19

Table 9. Results of two-sample t-test performed on daily catch rate for complete and incomplete trip interviews within each river section. Mean catch rates include brown and rainbow trout. The test was performed assuming equal variances, at alpha = 0.05.

River section	Complete trip n	Complete trip Mean daily catch rate	Incomplete trip n	Incomplete trip Mean daily catch rate	Test statistic	t-critical value	p-value
Upper	16	.243	6	.568	1.314	2.086	0.204
Middle	27	.398	9	.570	1.027	2.032	0.319
Lower	9	.387	14	.534	0.745	2.080	0.465

for all three sections; Table 10). Therefore, I pooled complete trip and incomplete trip interviews to estimate catch rates.

Seasonal catch rate estimates

I estimated catch rates for rainbow trout and brown trout by size class, day type, and river section. The highest weekday rainbow trout catch rate in the spring season was in the lower section for fish 10-16 inches in length (0.74 fish/hr; Table 11), which is the size class of rainbow trout stocked by VDGIF. This estimate was somewhat inflated due to one angler who was unusually successful. I could not estimate weekday catch rates for brown trout or rainbow trout in the middle section, because no anglers were interviewed during this time. On weekend days, the highest catch rate for rainbow trout was in the upper section for fish 10-16 inches (0.23 fish/hr; Table 11). No rainbow trout or brown trout >16 in. were caught by anglers interviewed in the spring season. Total rainbow trout catch rate was highest in the lower section in spring (0.31 fish/hr), followed by the upper section (0.16 fish/hr) and the middle section (0.07 fish/hr; Table 12).

Catch rates for brown trout in the spring were considerably lower than those for rainbow trout, except in the middle section (Table 12). No brown trout were caught by anglers I interviewed in the upper and lower sections. In the middle section, anglers caught 0.30 brown trout per hour <10 inches, while 0.02 fish/hr 10-16 inches in length were caught (Table 13).

The highest weekday catch rate for rainbow trout in the summer season was 0.09 fish/hr for fish <10 in., and 10-16 inches in the lower section (Table 14). Anglers we interviewed in the middle section on weekdays did not catch any rainbow trout. Only fish in the <10 in. size class were caught in the upper section on weekdays in the summer season (Table 14). On weekend days, the lower section had the highest catch rate for fish <10 in. (0.11 fish/hr) and 10-16 inches (0.15 fish/hr). The middle section yielded catch

Table 10. Results of F-test (alpha = 0.05) performed on daily catch rates for complete and incomplete trip interviews within each river section. Catch rates include brown and rainbow trout.

River section	Complete trip		Incomplete trip		F value	F-critical value	p-value
	n	Variance	n	Variance			
Upper	16	0.273	6	0.247	0.906	0.345	0.601
Middle	27	0.170	9	0.254	1.496	2.321	0.207
Lower	9	0.142	14	0.258	1.817	3.259	0.201

Table 11. Catch rates (fish/hr) for rainbow trout in three sections of the Smith River during the spring season (March 18-May 24, upper and lower sections; March 1-May 24, middle section). All measurements are in inches.

River Section	Size Class <10	10-16	>16	Total
		Weekdays		
Upper	.07	0	0	.07
Middle[a]	----	----	----	----
Lower	.37	.74	0	1.11
		Weekend days		
Upper	0	.23	0	.23
Middle	.04	0	0	.04
Lower	0	.05	0	.05

[a]no interviews were obtained during the week in the spring season

Table 12. Catch rates (fish/hr) for rainbow trout and brown trout in three sections of the Smith River during the spring, summer, and fall seasons. Estimates include fish caught on weekdays and weekend days.

	Season			
River Section	Total Spring	Total Summer	Total Fall	Overall
		Rainbow trout		
Upper	.16	.03	.17	.10
Middle	.07	.07	.01	.05
Lower	.31	.22	.52	.31
		Brown trout		
Upper	0	.27	.22	.20
Middle	.39	.37	.56	.43
Lower	0	.17	.05	.07

Table 13. Catch rates (fish/hr) for brown trout in three sections of the Smith River during the spring season (March 18-May 24, upper and lower sections; March 1-May 24, middle section). All measurements are in inches.

	Size Class			
River Section	<10	10-16	>16	Overall
		Weekdays		
Upper	0	0	0	0
Middle[a]	----	----	----	----
Lower	0	0	0	0
		Weekend days		
Upper	0	0	0	0
Middle	.30	.02	0	.32
Lower		0	0	0

[a]no interviews were obtained during the week in the spring season

Table 14. Catch rates (fish/hr) for rainbow trout in three sections of the Smith River during the summer season (May 24-September 4). All measurements are in inches.

	Size Class			
River Section	<10	10-16	>16	Overall
		Weekdays		
Upper	.03	0	0	.03
Middle	0	0	0	0
Lower	.09	.09	0	.18
		Weekend days		
Upper	0	.05	0	.05
Middle	.03	.03	.01	.07
Lower	.11	.15	0	.26

rates of 0.03 fish/hr for the same two size classes. Only one rainbow trout >16 in. was caught during the summer season in the middle section. The lower section had the highest total catch rate for rainbow trout in summer (0.22 fish/hr; Table 12).

Brown trout catch rates on weekdays in the summer season were zero for all size classes in both the middle and lower sections (Table 15). The only brown trout caught in summer were <10 in. from the upper section (0.19 fish/hr). Anglers I interviewed were much more successful catching brown trout on weekend days in the summer season. Catch rates were highest on weekend days in the summer for fish <10 in. in all three sections (0.32 fish/hr in the upper section, 0.31 fish/hr in the middle section, 0.14 fish/hr in the lower section; Table 15). Catch rates for brown trout >16 in. were 0.01 fish/hr in both the upper and middle sections. No brown trout >16 in. were caught in the lower section. The middle section had the highest total brown trout catch rate in summer (0.37 fish/hour), followed by the upper section (0.27 fish/hr) and lower section (0.17 fish/hr; Table 12).

In the fall season on weekdays, the only rainbow trout caught were 10-16 in., with the highest catch rate (0.57 fish/hour) in the lower section (Table 16). No rainbow trout were caught in the middle section on weekdays in the fall season. On weekend days in the middle section, only rainbow trout <10 in. were caught (0.01 fish/hr). Anglers in the lower section caught rainbow trout 10-16 inches in length at a rate of 0.39 fish/hr on weekend days. The lower section had the highest total rainbow trout catch rate in fall (0.52 fish/hr), followed by the upper section (0.17 fish/hr) and middle section (0.01 fish/hr; Table 12).

Catch rates for brown trout in the fall were higher on weekdays than on weekend days (Table 17). Brown trout <10 in. and 10-16 in. were caught at a rate of 0.67 fish/hr and 0.08 fish/hr, respectively (Table 17). No brown trout were caught in the lower section on weekdays during the fall season. The middle section also had the highest brown

Table 15. Catch rates (fish/hr) for brown trout in three sections of the Smith River during the summer season (May 24-September 4). All measurements are in inches.

	Size Class			
River Section	<10	10-16	>16	Overall
		Weekdays		
Upper	.19	0	0	.19
Middle	0	0	0	0
Lower	0	0	0	0
		Weekend days		
Upper	.32	.05	.01	.38
Middle	.31	.05	.01	.37
Lower	.14	.08	0	.22

Table 16. Catch rates (fish/hr) for rainbow trout in three sections of the Smith River during the fall season (September 4-December 17). All measurements are in inches.

River Section	Size Class <10	10-16	>16	Overall
		Weekdays		
Upper	0	.21	0	.21
Middle	0	0	0	0
Lower	0	.57	0	.57
		Weekend days		
Upper	.09	.04	0	.13
Middle	.01	0	0	.01
Lower	.11	.39	0	.50

Table 17. Catch rates (fish/hr) for brown trout in three sections of the Smith River during the fall season (September 4-December 17). All measurements are in inches.

	Size Class			
River Section	<10	10-16	>16	Overall
		Weekdays		
Upper	.16	0	0	.16
Middle	.67	.08	0	.75
Lower	0	0	0	0
		Weekend days		
Upper	.26	0	0	.26
Middle	.43	.09	0	.52
Lower	0	.07	0	.07

trout catch rate on weekend days in the fall season. Brown trout <10 in. were caught at a rate of 0.43 fish/hr in the middle section, and 0.26 fish/hr in the upper section. The middle section had the highest total brown trout catch rate in fall (0.43 fish/hr), followed by the upper section (0.20 fish /hr) and lower section (0.07 fish/hr; Table 12).

Overall catch rate for rainbow trout in the upper section was highest in the fall season (0.17 fish/hr; Table 12). Anglers in the middle section caught rainbow trout at the same rate in spring and summer (0.07 fish/hr), while the fall season was best in the lower section (0.57 fish/hr). Little or no evidence exists showing rainbow trout reproduction. All the rainbow trout caught are essentially all stocked fish. The summer season produced the highest total brown trout catch rate in the upper section (0.27 fish/hr) and lower section (0.17 fish/hr; Table 12). Anglers in the middle section caught brown trout at a rate of 0.56 fish/hr in the fall season, the highest seasonal brown trout catch rate for anglers in the middle section.

Size class specific catch rate estimates

The lower section had the highest overall catch rate for rainbow trout <10 inches (0.04 fish/hr; Table 18). The highest catch rate for fish 10-16 in. was in the lower section (0.15 fish/hr; Table 18). Rainbow trout >16 in. were caught only in the middle section.

Brown trout <10 in. were caught at a rate of 0.35 fish/hr in the middle section and 0.19 fish/hr in the upper section, both of which were the highest size class catch rates in these two sections. Anglers in the middle and upper sections were not as successful catching brown trout 10-16 in. as they were fish <10 inches. Anglers caught brown trout 10-16 in. at a rate of 0.005 fish/hr in the upper section, and 0.07 fish/hr in the middle section (Table 18). Catch rates for brown trout < 10 in. and 10-16 inches were the same in the lower section (0.03 fish/hr; Table 18).

Table 18. Overall catch rates (fish/hr) for rainbow trout and brown trout for three size classes. Catch rates include spring, summer, and fall seasons, and weekdays and weekend days.

	Size class		
River section	< 10 inches	10-16 inches	> 16 inches
		Rainbow trout	
Upper	.02	.05	0
Middle	.02	.03	.002
Lower	.04	.15	0
		Brown trout	
Upper	.19	.005	0
Middle	.35	.07	.002
Lower	.03	.03	0

Opening day catch rate estimates

I estimated catch rate for fish caught on opening day by species and river section only. On opening day, rainbow trout catch rates were highest in the upper section (0.50 fish/hr), followed by the lower section (0.31 fish/hr) and middle section (0.12 fish/hr; Table 19).

Anglers caught brown trout at a very low rate in the upper section (0.03 fish/hr) and lower section (0.01 fish/hr) on opening day (Table 19). The middle section produced the highest brown trout catch rate of any section on opening day (0.55 fish/hr).

Total Catch Estimates

Seasonal catch estimates

The highest total catch estimate for rainbow trout 10-16 inches on weekdays in the spring season was in the lower section (13,985, 80%CI=21-27,949; Table 20). Estimated catch for fish 10-16 in. accounted for 89% of the total weekday rainbow trout catch estimate in spring (including all sections). Anglers caught an estimated 100 rainbow trout in the upper section on weekdays, all less than 10 inches in length (Table 20). I could not estimate total catch of rainbow trout and brown trout in the middle section on weekdays during spring because I did not interview any anglers. Anglers in the upper and lower sections caught no brown trout on weekdays in the spring season. The upper section produced the highest total estimated catch for rainbow trout on weekend days in spring, of which 89% were 10-16 inches (Table 20). Ninety-one percent of brown trout caught on weekend days in the middle section in spring were less than 10 inches (Table 21). Total estimated catch of rainbow trout and brown trout in the spring season was 17,521 and 747, respectively.

Table 19. Catch rate (fish/hr) estimates for rainbow trout and brown trout on opening day of trout season (March 18) in three sections of the Smith River.

River section	Rainbow	Brown	Overall
Upper	.50	.03	.53
Middle	.12	.55	.67
Lower	.31	.01	.32

Table 20. Total estimated catch for rainbow trout in three sections of the Smith River during the spring season (March 18-May 24, upper and lower sections; March 1-May 24, middle section). Eighty percent confidence interval is given in parentheses. All measurements are in inches.

	Size Class			
River Section	<10	10-16	>16	Total
		Weekdays		
Upper	100	0	0	100
	(0-218)	----	----	
Middle[a]	----	----	----	----
Lower	1,626	13,985	0	15,611
	(0-3,323)	(21-27,949)	----	
Total	1,726	13,985	0	15,711
		Weekend days		
Upper	0	1,615	0	1,615
	----	(42-3,188)	----	
Middle	79	0	0	79
	(0-188)	----	----	
Lower	0	116	0	116
	----	(0-294)	----	
Total	79	1,731	0	1,810
Grand total	1,805	15,716	0	17,521

[a]no interviews were obtained in the middle section during the week in the spring season

Table 21. Total estimated catch for brown trout in three sections of the Smith River during the spring season (March 18-May 24, upper and lower sections; March 1-May 24, middle section). Eighty percent confidence interval is given in parentheses. All measurements are in inches.

	Size Class			
River Section	<10	10-16	>16	Total
		Weekdays		
Upper	0 ----	0 ----	0 ----	0
Middle[a]	----	-----	----	----
Lower	0 ----	0 ----	0 ----	0 ----
Total	0	0	0	0
		Weekend days		
Upper	0 ----	0 ----	0 ----	0
Middle	678 (0-1,494)	69 (0-186)	0 ----	747
Lower	0 ----	0 ----	0 ----	0
Total	678	69	0	747
Grand total	678	69	0	747

[a]no interviews were obtained in the middle section during the week in the spring season

Anglers caught an estimated 319 rainbow trout on weekdays during the summer season, of which 59% were fish < 10 in. (Table 22). The lower section accounted for one-half of the total estimate rainbow trout catch on weekend days in summer, with the majority of fish < 10 inches (Table 22).

All of the estimated 186 brown trout caught on weekdays during the summer were < 10 in. in length and from the upper section (Table 23). Anglers in the middle section accounted for 45% of the total estimated weekend day brown trout catch. Eighty-seven percent of the brown trout caught on weekend days were fish <10 in. in length.

Seventy-two percent of rainbow trout caught on weekdays in the fall were 10-16 in. and from the lower section (Table 24). Rainbow trout 10-16 in. were also the most frequently caught size of fish on weekend days in the fall season.

Anglers in the middle section caught more brown trout (2,383) in fall than in any other season (Table 25). Eighty-four percent of brown trout caught during the fall in the middle section were <10 in. Anglers caught an estimated 683 and 230 brown trout during fall in the upper and lower sections, respectively (Table 25).

Overall catch estimates

The lower section yielded the highest overall catch estimate of rainbow trout <10 in. in length (3,433) and 10-16 in. in length (16,509; Table 26). However, this estimate is somewhat inflated due to one angler who was unusually successful. The middle section accounted for 64% of the overall estimated brown trout catch. Eighty-six percent of the brown trout caught were <10 in. in length (Table 26). An estimated 40 trout (7 rainbow trout, 33 brown trout) >16 in. were caught in all three sections combined.

Table 22. Total estimated catch for rainbow trout in three sections of the Smith River during the summer season (May 24-September 4). Eighty percent confidence interval is given in parentheses. All measurements are in inches.

	Size Class			
River Section	<10	10-16	>16	Total
		Weekdays		
Upper	31	0	0	31
	(2-60)	----	----	
Middle[a]	----	----	----	----
Lower	157	131	0	288
	(0-347)	(0-269)	----	
Total	188	131	0	319
		Weekend days		
Upper	0	383	0	383
	----	(59-708)	----	
Middle	124	103	7	234
	(10-238)	(42-164)	(0-16)	
Lower	492	131	0	623
	(180-804)	(0-269)	----	
Total	616	617	7	1,240
Grand total	804	748	7	1,559

[a]no interviews were obtained in the middle section during the week in the summer season

Table 23. Total estimated catch of brown trout in three sections of the Smith River during the summer season (May 24-September 4). Eighty percent confidence interval is given in parentheses. All measurements are in inches.

	Size Class			
River Section	<10	10-16	>16	Total
		Weekdays		
Upper	186 (13-359)	0 ----	0 ----	186
Middle[a]	----	----	----	----
Lower	0 ----	0 ----	0 ----	0
Total	186	0	0	186
		Weekend days		
Upper	748 (484-1,012)	61 (18-104)	8 (0-17)	817
Middle	941 (352-1,530)	120 (13-227)	25 (0-55)	1,086
Lower	382 (10-753)	107 (34-180)	0 ----	489
Total	2,071	288	33	2,392
Grand total	2,257	288	33	2,578

[a]no interviews were obtained in the middle section during the week in the summer season

Table 24. Total estimated catch of rainbow trout in three sections of the Smith River during the fall season (September 4-December 17). Eighty percent confidence interval is given in parentheses. All measurements are in inches.

	Size Class			
River Section	<10	10-16	>16	Total
		Weekdays		
Upper	0 ----	336 (95-577)	0 ----	336
Middle	0 ----	0 ----	0 ----	0
Lower	0 ----	880 (203-1,558)	0 ----	880
Total	0	1,216	0	1,216
		Weekend days		
Upper[a]	117 ----	59 ----	0 ----	176
Middle	8 (0-18)	0 ----	0 ----	8
Lower	345 (51-639)	1,266 (187-2,345)	0 ----	1,611
Total	470	1,325	0	1,795
Grand total	470	2,541	0	3,011

[a]no confidence interval was calculated because the point estimate is based on interviews from only one day

Table 25. Total estimated catch of brown trout in three sections of the Smith River during the fall season (September 4-December 17). Eighty percent confidence interval is given in parentheses. All measurements are in inches.

	Size Class			
River Section	<10	10-16	>16	Total
		Weekdays		
Upper	332 (94-570)	0 ----	0 ----	332
Middle	1,385 (921-1,849)	145 (41-249)	0 ----	1,530
Lower	0 ----	0 ----	0 ----	0
Total	1,717	145	0	1,862
		Weekend days		
Upper[a]	351 ----	0 ----	0 ----	351
Middle	694 (547-841)	159 (113-205)	0 ----	853
Lower	0 ----	230 (34-426)	0 ----	230
Total	1,045	389	0	1,434
Grand total	2,762	534	0	3,296

[a]no confidence interval was calculated because the point estimate is based on interviews from only one day

Table 26. Overall estimated catch for rainbow trout and brown trout. Estimates include weekdays and weekend days and all three seasons. All measurements are in inches.

River Section	< 10	10-16	> 16	Total
		Rainbow trout [a]		
Upper	248	2,393	0	2,641
Middle	211	103	7	321
Lower	3,433	16,509	0	19,942
		Brown trout [b]		
Upper	1,617	61	8	1,686
Middle	3,698	493	25	4,216
Lower	382	337	0	719

[a]total estimated rainbow trout catch = 22,904

[b]total estimated brown trout catch = 6,621

Total estimated catch on opening day

Anglers caught an estimated 916 rainbow trout, and 113 brown trout on opening day (Table 27). Seventy percent of rainbow trout were caught in the lower section. Very few rainbow trout (16) were caught in the middle section. Anglers in the middle section, however, caught many more brown trout (74), accounting for 66% of total estimated brown trout catch on opening day (Table 27).

Total Harvest Estimates

Seasonal harvest estimates

In the spring season, anglers harvested an estimated 15, 305 rainbow trout during the week, with 91% of fish harvested from the lower section (Table 28). This estimate is somewhat inflated due to one angler who was unusually successful. The VDGIF only stocked a total of 12,610 rainbow trout in the lower section during the spring period. Anglers harvested 97% of the rainbow trout caught on weekdays in spring. Total estimated rainbow trout harvest on weekend days was 1,731 (Table 25). Ninety-three percent of harvested rainbow trout were 10-16 in. in length and were caught in the upper section. Anglers I interviewed caught no brown trout on weekdays in the upper and lower sections, nor in any of the three sections on weekend days during the spring season (Table 29).

Total estimated harvest of both species was low in the summer season (Tables 29 and 30), compared to the spring harvest estimate (Tables 28). Anglers harvested an estimated 46 (80%CI=0-100) rainbow trout in the 10-16 in. size range in the lower section on weekdays during the summer (Table 29). Anglers harvested only 13% of the rainbow trout they caught on weekdays (Tables 22, 29). The lower section also had the highest weekday rainbow trout harvest estimate (432), 85% of which were fish <10 in. in

Table 27. Total estimated catch for rainbow trout and brown trout on opening day of trout season (March 18) in three sections of the Smith River.

River section	Rainbow	Brown	Total
Upper	255	16	271
Middle	16	74	90
Lower	645	23	668

Table 28. Total estimated harvest for rainbow trout in three sections of the Smith River during the spring season (March 18-May 24, upper and lower sections; March 1-May 24, middle section). Eighty percent confidence interval is given in parentheses. All measurements are in inches.

	Size Class			
River Section	<10	10-16	>16	Total
		Weekdays		
Upper	100 (0-218)	0 ----	0 ----	100
Middle[a]	----	----	----	----
Lower	1,220 (0-2,492)	13,985 (21-27,949)	0 ----	15,205
Total	1,320	13,985	0	15,305
		Weekend days		
Upper	0 ----	1,615 (42-3,188)	0 ----	1,615
Middle	0 ----	0 ----	0 ----	0
Lower	0 ----	116 (0-294)	0 ----	116
Total	0	1,731	0	1,731
Grand total	1,320	15,716	0	17,036

[a]no interviews were obtained in the middle section during the week in the spring season

Table 29. Total estimated harvest for rainbow trout in three sections of the Smith River during the summer season (May 24-September 4). Eighty percent confidence interval is given in parentheses. All measurements are in inches.

River Section	Size Class <10	10-16	>16	Total
		Weekdays		
Upper	0 ----	0 ----	0 ----	0
Middle[a]	----	----	----	----
Lower	0 ----	46 (0-100)	0 ----	46
Total	0	46	0	46
		Weekend days		
Upper	0 ----	36 (0-77)	0 ----	36
Middle	0 ----	0 ----	7 (0-16)	7
Lower	364 (26-702)	68 (2-135)	0 ----	432
Total	364	104	7	475
Grand total	364	150	7	521

[a]no interviews were obtained in the middle section during the week in the summer season

length (Table 29). Anglers we interviewed did not catch any brown trout on weekdays in the upper and lower sections. I could not estimate summer harvest in the middle section because we did not interview any anglers during this time.

Anglers harvested an estimated 343 brown trout on weekend days in summer, 271 (80%CI=0-661) of which were fish <10 in. in length from the lower section (Table 30). Total estimated brown trout harvest in summer is 13% of total estimated brown trout catch.

Anglers harvested an estimated 1,216 rainbow trout on weekdays in fall, none of which were harvested in the middle section (Table 31). Fish 10-16 in. in length comprised the entire weekday harvest of rainbow trout in the fall. Anglers I interviewed harvested 100% of the rainbow trout they caught during the fall season (Table 31). On weekend days, anglers harvested an estimated 1,611 rainbow trout, none of which were harvested in the middle section (Table 31). Of the total estimated rainbow trout harvest, 1,266 (80% CI=187-2,345; 79%) were fish 10-16 in. in length and from the lower section (Table 31). Anglers harvested nearly all (94%) rainbow trout they caught in fall (3,011; Tables 24 and 31).

Overall harvest estimates

Overall harvest of rainbow trout was 20,384 fish, 90% of the total estimated rainbow trout catch (Figure 4), and 63% of the total number of rainbow trout VDGIF stocked during 1995 (32,350 fish). Anglers in the lower section harvested the highest percentage of their total estimated catch, followed by the upper section. Anglers in the middle section harvested only 2% of their total estimated rainbow trout catch. Overall, anglers harvested a much lower proportion of their brown trout catch (5%), compared to the proportion of rainbow trout harvested (Figure 5). Anglers in the lower section harvested the highest proportion of their total estimated catch of brown trout (43%).

Table 30. Total estimated harvest for brown trout in three sections of the Smith River during the summer season (May 24-September 4). No brown trout were harvested on weekdays. Eighty percent confidence interval is given in parentheses. All measurements are in inches.

	Size Class			
River Section	<10	10-16	>16	Total
		Weekend days		
Upper	36	0	0	36
	(0-77)	----	----	
Middle	0	0	0	0
	----	----	----	
Lower	271	36	0	307
	(0-661)	(0-72)	----	
Total	307	36	0	343

[a]no interviews were obtained in the middle section during the week in the summer season

Table 31. Total estimated harvest for rainbow trout in three sections of the Smith River during the fall season (September 4-December 17). Eighty percent confidence interval is given in parentheses. All measurements are in inches.

River Section	Size Class <10	Size Class 10-16	Size Class >16	Total
		Weekdays		
Upper	0 ----	336 (95-577)	0 ----	336
Middle	0 ----	0 ----	0 ----	0
Lower	0 ----	880 (203-1,558)	0 ----	880
Total	0	1,216	0	1,216
		Weekend days		
Upper	0 ----	0 ----	0 ----	0
Middle	0 ----	0 ----	0 ----	0
Lower	345 (51-639)	1,266 (187-2,345)	0 ----	1,611
Total	345	1,266	0	1,611
Grand total	345	2,482	0	2,827

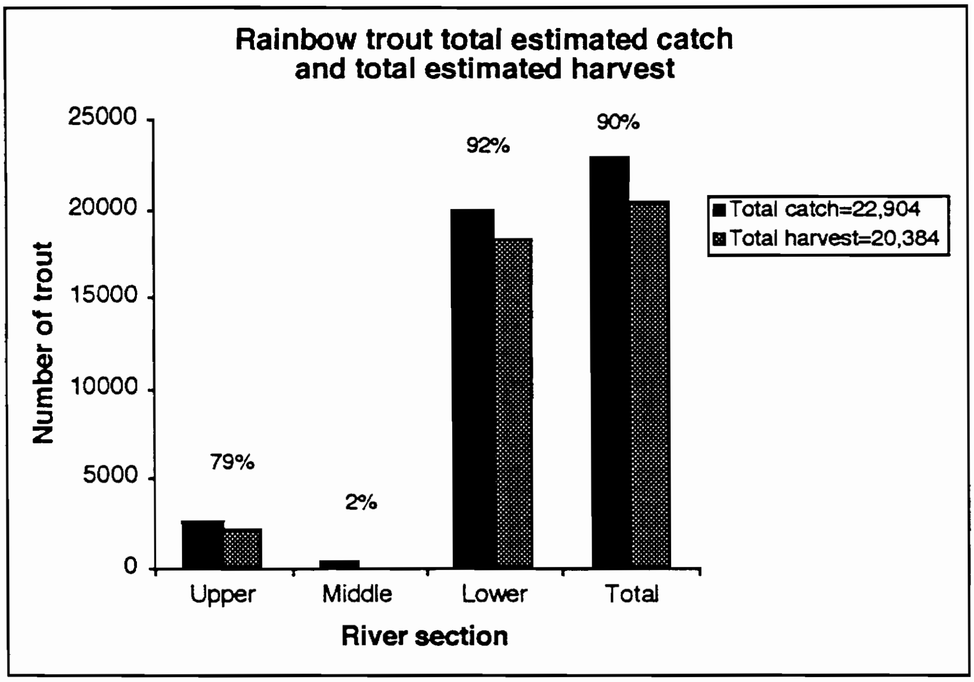


Figure 4. Total estimated catch and total estimated harvest of rainbow trout in three sections of the Smith River. Estimates include both day types, all size classes, and all seasons. Estimates do not include opening day of trout season. Percentages represent proportion of total estimated harvest to total estimated catch.

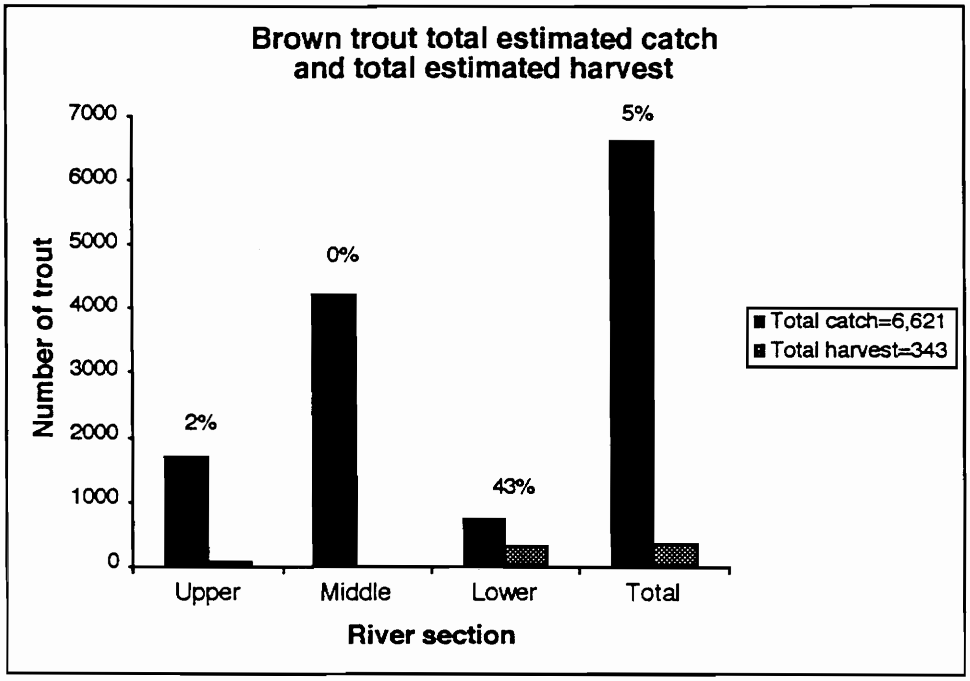


Figure 5. Total estimated catch and total estimated harvest of brown trout in three sections of the Smith River. Estimates include both day types, all size classes, and all seasons. Estimates do not include opening day of trout season. Percentages represent proportion of total estimated harvest to total estimated catch.

Harvest was negligible (2%) in the upper section, and nonexistent in the middle section (Figure 5).

Fish 10-16 in. in length comprised most of the total catch and total harvest of rainbow trout (Figure 6). Brown trout <10 in. in length comprised the majority of total catch (86%) and total harvest (90%; Figure 7).

Total estimated harvest on opening day

Anglers harvested an estimated 890 rainbow trout (245 upper section, 0 middle section, 645 lower section) on opening day. They harvested 97% of the total estimated rainbow trout caught on opening day (Table 32). Anglers harvested a considerably smaller portion (27 of 113, 24%) of estimated brown trout catch. No brown trout were harvested in the middle section on opening day.

Philpott Reservoir

Recreational Use Estimates

Seasonal angler effort

In the spring season, boat angler effort on weekdays was highest in the middle section (6,845 angler-hours, 80% CI=3,166-10,524), and lowest in the upper section (2,771 angler hours, 80% CI=2,447-3,094; Table 33). Weekend day effort was lower than weekday effort in all three sections. The highest weekend day effort was in the middle section (6,707 angler-hours, 80% CI=2,937-10,475). Total estimated boat angler effort in spring was 26,685 angler-hours, of which 14,359 angler-hours were expended on weekdays, and 12,326 angler-hours were expended on weekend days. Bank angler effort was considerably lower than boat angler effort on both weekdays and weekend days in

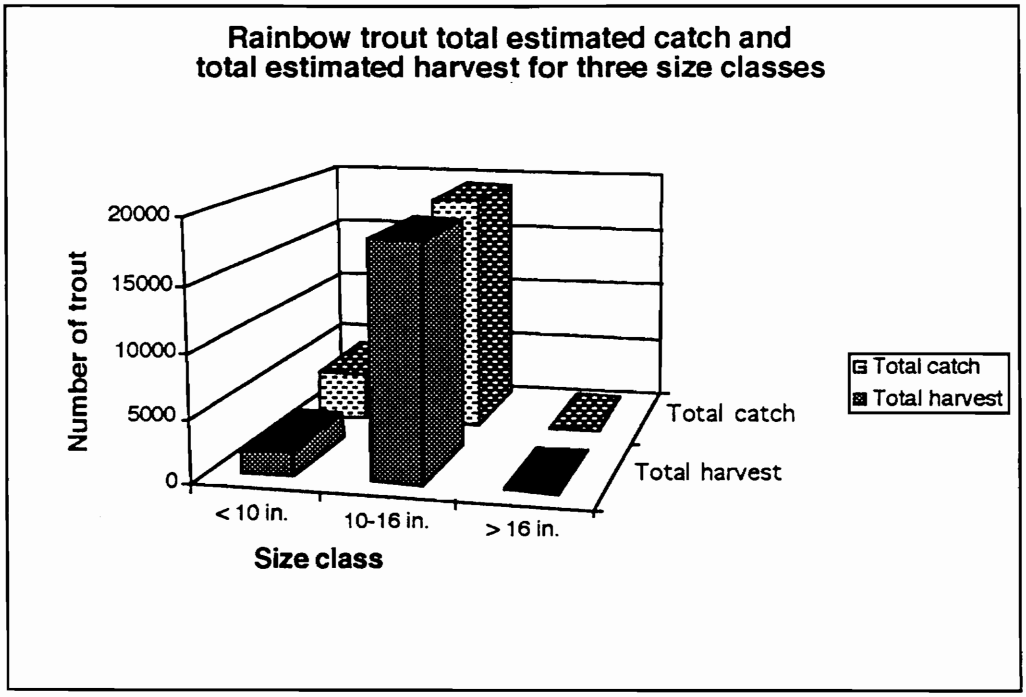


Figure 6. Total estimated catch and total estimated harvest for rainbow trout for three size classes. Estimates include both day types, all river sections, and all seasons. Estimates do not include opening day.

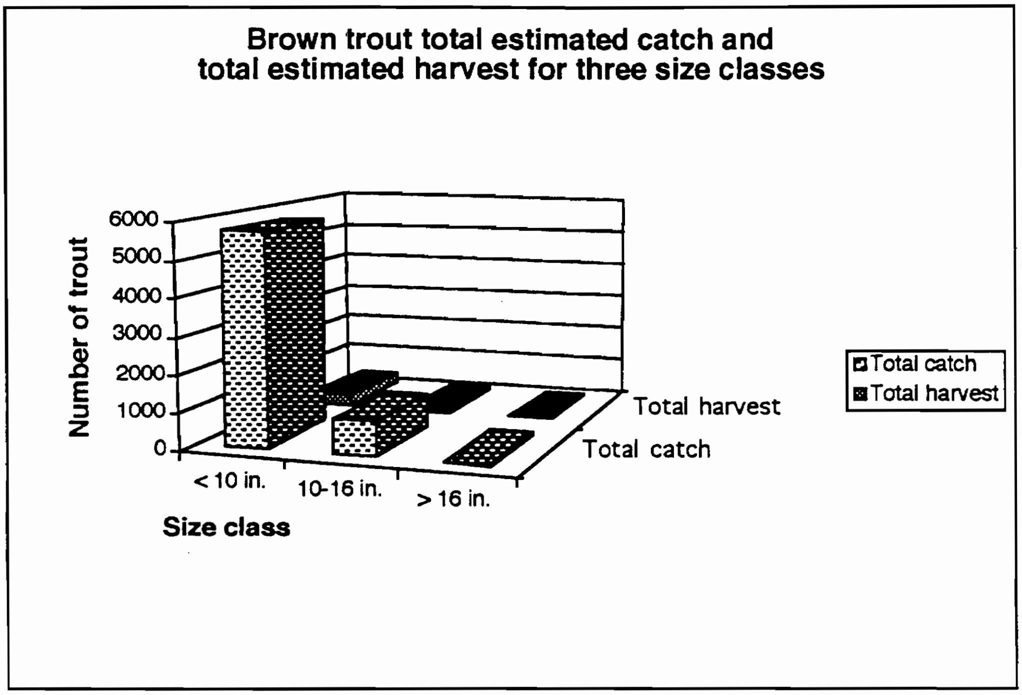


Figure 7. Total estimated catch and total estimated harvest for brown trout for three size classes. Estimates include both day types, all river sections, and all seasons. Estimates do not include opening day.

Table 32. Total estimated harvest for rainbow trout and brown trout on opening day of trout season (March 18) in three sections of the Smith River.

River section	Rainbow[a]	Brown[b]	Total
Upper	245	4	249
Middle	0	0	0
Lower	645	23	668

[a]total estimated rainbow trout harvest on opening day = 890

[b]total estimated brown trout harvest on opening day = 27

Table 33. Angler effort estimates (boat angler and bank anglers) on Philpott Reservoir for each day type and sampling season.

Reservoir section	Boat angler				Bank angler			
	Weekday	80% CI	Weekend day	80% CI	Weekday	80% CI	Weekend day	80% CI
				Spring (February 18-May 25)				
Lower	4,743	2,954-6,532	3,662	1,275-6,049	617	120-1,114	422	0-924
Middle	6,845	3,166-10,524	6,707	2,937-10,475	264	6-523	541	245-838
Upper[a]	2,771	2,447-3,094	1,957	1,179-2,736	100	0-221	207	97-316
Total	14,359	----	12,326	----	981	----	1,170	----
				Summer (May 26,-September 4)				
Lower	2,361	1,570-3,152	5,010	3,241-6,778	1,276	564-1,988	1,519	906-2,133
Middle	3,577	2,568-4,586	6,326	4,807-7,845	667	462-873	1,538	1,194-1,882
Total	5,938	----	11,336	----	1,943	----	3,057	----
				Fall (September 5 - November 30)				
Lower	2,615	1,875-3,355	2,167	1,684-2,651	412	232-592	122	60-183
Middle	3,347	2,538-4,155	2,808	2,408-3,208	136	25-248	369	217-522
Total	5,962	----	4,975	----	548	----	491	----
Grand total	26,259	----	28,637	----	3,472	----	4,718	----

[a]sampling in the upper section occurred from February 18 through April 30.

spring (Table 33). The highest bank angler effort occurred in the lower section on weekdays (617 angler-hours, 80% CI=120-1,114). Overall, bank angler effort accounted for 8% of total angler effort in spring.

Total weekday boat angler effort declined from 11,588 angler-hours in spring to 5,938 angler-hours in summer, a 49% decrease (Table 33). Highest weekday boat angler effort during the summer was in the middle section (3,577 angler-hours, 80% CI=2,568-4,586). Effort by boat anglers on weekend days increased from spring (10,369 angler-hours) to summer (11,336 angler-hours). Slightly more than one-half of weekend summer boat angler effort occurred in the middle section. Bank angler effort increased from spring to summer on both weekdays (881 angler-hours in spring to 1,943 angler-hours in summer), and weekend days (963 angler-hours in spring to 3,057 angler-hours in summer). Bank angler effort accounted for 29% of total estimated angler effort in summer.

Effort by boat anglers during the fall was slightly higher in the middle section (3,347 angler-hours) than in the lower section (2,615 angler-hours; Table 33). Total estimated
effort on weekdays in fall by boat anglers was 5,962 angler-hours. Weekend day boat angler effort declined from 11,336 angler-hours in summer to 4,975 angler-hours in fall (Table 33). Weekend day bank angler effort also declined from 3,057 angler-hours in summer to 491 angler-hours in fall (Table 33). Total estimated bank angler effort declined from 5,001 angler-hours in summer to 1,039 angler-hours in fall. Total estimated effort by bank anglers on weekdays during the fall season was 548 angler-hours, 75% of which occurred in the lower section. Total bank angler effort on weekend days was 491 angler-hours, of which 75% occurred in the middle section. Bank angler effort comprised a small portion (10%) of total estimated angler effort in fall.

Overall angler effort, combining the lower and middle sections, was highest in spring (23,801 angler-hours), slightly lower in summer (22,275 angler-hours) and lowest in fall (11,975 angler-hours; Table 34). Boat angler effort was highest in spring (21,957 angler-hours-not including effort in the upper section), while bank angler effort was highest in summer (5,001 angler-hours). The majority of angler effort occurred in spring (41%), decreasing in summer (38%), and fall (21%). Overall effort by anglers of all types was 63,181 angler-hours, nearly identical to the 62,839 hours of angler effort estimated in 1981 (Whitehurst 1981).

Effort by tournament anglers

Local anglers held tournaments on Monday and Friday nights from April 28 through October 27. In addition, three larger, special tournaments were held on April 23, August 19, and October 15. I estimated angler effort for each tournament type and total tournament angler effort. Monday night tournaments generated an estimated 1,512 angler-hours of effort, while Friday night tournaments generated 4,212 angler-hours of effort (Table 35). One hundred twenty one anglers participated in the three special tournaments

Seasonal recreational use

Recreational use by pleasure boaters and personal watercraft operators was low in spring (Table 36). An estimated 1,687 hours (80% CI=0-3,703) were expended by pleasure boaters in the middle section on weekend days, which accounted for total weekend day use by pleasure boaters in spring (Table 36). I saw no personal watercraft operators in either the lower or middle sections in spring. Personal watercraft are not permitted above Union Creek Bridge, so I did not estimate use by this group in the upper section.

Recreational use by pleasure boaters increased dramatically from spring (1,854 hours) to summer (84,427 hours), then declined again in fall (6,004 hours; Table 36). Overall, use on weekend days comprised 61% of total estimated use by pleasure boaters in summer (Table 36). Recreational use by personal watercraft operators during the

Table 34. Estimates of total recreational use on Philpott Reservoir for each sampling season. Estimates include use on weekdays and weekend days.

Reservoir section	User group type Boat angler	Bank angler	Pleasure boater	Personal watercraft
		Spring (February 18-May 25)		
Lower	8,405	1,039	167	0
Middle	13,552	805	1,687	0
Upper[a]	4,728	307	0	0
Total	26,685	2,151	1,854	0
		Summer (May 26,-September 4)		
Lower	7,371	2,796	41,745	2,727
Middle	9,903	2,205	42,682	1,338
Total	17,274	5,001	84,427	4,065
		Fall (September 5 - November 30)		
Lower	4,782	534	3,070	66
Middle	6,154	505	2,934	168
Total	10,936	1,039	6,004	234
Total user group effort[b]	54,895	8,191	92,285	4,299

[a]sampling in the upper section occurred from February 18 through April 30.

[b]total angler effort = 63,186 angler-hours. Estimate does not include tournament angling. Whitehurst (1981) angler effort estimate from aerial counts = 62,839 angler-hours.

Table 35. Tournament angler effort estimates (angler-hours) from February 18 through November 31 on Philpott Reservoir.

Tournament description/date	Total number of anglers	Hours fished per tournament	# of tournaments during study[a]	Total angler hours[b]
Monday night	14[a]	4.5	24	1,512
Friday night	20[a]	6	27	4,212
April 23	68	8	----	544
August 19	27	6	----	162
October 15	26	9	----	234

[a]average number of anglers per tournament
[b]total estimated tournament angler effort = 6,664 angler hours

Table 36. Recreational use estimates (pleasure boaters and personal watercraft operators) on Philpott Reservoir for each day type and sampling season.

Reservoir section	Pleasure boaters				Personal watercraft			
	Weekday	80% CI	Weekend day	80% CI	Weekday	80% CI	Weekend day	80% CI
				Spring (February 18-May 25)				
Lower	167	0-392	0	----	----	----	----	----
Middle	0	----	1,687	0-3,703	----	----	----	----
Upper[a]	----	----	----	----	----	----	----	----
Total	167	----	1,687	----	----	----	----	----
				Summer (May 26,-September 4)				
Lower	18,888	10,091-27,684	22,857	11,381-34,333	1,538	722-2,355	1,189	539-1,839
Middle	13,745	7,957-19,533	28,937	22,757-35,117	250	0-580	1,088	878-1,298
Total	32,633	----	51,794	----	1,788	----	2,277	----
				Fall (September 5 - November 30)				
Lower	1,366	989-1,742	1,704	882-2,527	0	----	66	0-136
Middle	1,330	1,001-1,658	1,604	721-2,487	84	0-184	84	3-165
Total	2,696	----	3,308	----	84	----	150	----
Grand total	35,496	----	56,789	----	1,872	----	2,427	----

[a]sampling in the upper section occurred from February 18 through April 30.

summer was highest in the lower section on both weekdays (1,538 hours, 80% CI=722-2,355) and weekend days (1,189 hours, 80% CI=539-1,839). Total estimated summer use by personal watercraft operators was 4,065 hours.

Recreational use by pleasure boaters on weekdays in fall was nearly equal in the lower section (1,366 hours, 80% CI=989-1,742) and middle section (1,330 hours, 80% CI=1,001-1,658; Table 36). Total estimated use by pleasure boaters in fall was highest on weekend days (3,308 hours). Use on weekend days was nearly equal in the lower section (1,704 hours, 80% CI=882-2,527) and middle section (1,604 hours, 80% CI=721-2,487). Recreational use by personal watercraft operators was low in both sections and on both day types in fall (Table 36). Total estimated recreational use by personal watercraft users in fall was 234 hours.

Recreational use by pleasure boaters was much higher in summer (84,427 hours) than fall (6,004 hours) or spring (336 hours; Table 34). Overall use by pleasure boaters was 92,285 hours, 92% of which occurred in summer (Table 34). Personal watercraft operators followed the same seasonal use pattern as pleasure boaters, with highest use occurring in summer (4,065 hours).

Catch Rate Estimates

Black bass

In the spring, catch rates for black bass were higher on weekdays (0.15 fish/hr) than on weekend days (0.09 fish/hr; Table 37). Total black bass catch rate in spring was 0.11 fish/hr. The highest catch rate for black bass in summer occurred on weekend days (0.17 fish/hr). Total summer black bass catch rate was 0.16 fish/hr. Catch rates of black bass during the fall increased dramatically to 0.77 fish/hr on weekdays and 0.62 fish/hr on weekend days. Total catch rate of black bass during the fall season was

Table 37. Catch rates (fish/hr) for black bass (largemouth bass, smallmouth bass), crappie, sunfish, and catfish on weekdays and weekend days in each season. Total catch rate includes fish caught on weekdays and weekend days.

	Day type		
Species[a]	Weekday	Weekend day	Total
	Spring (February 18-May 24)		
Black bass	0.15	0.09	0.11
Crappie	0.00	0.16	0.11
Sunfish	0.00	0.00	0.00
Catfish	0.00	0.01	0.004
	Summer (May 25-September 4)		
Black bass	0.10	0.17	0.16
Crappie	0.00	0.02	0.02
Sunfish	0.18	0.28	0.27
Catfish	0.02	0.01	0.01
	Fall (September 5-November 30)		
Black bass	0.77	0.62	0.69
Crappie	0.00	0.04	0.02
Sunfish	0.07	0.09	0.08
Catfish	0.00	0.02	0.01

[a]interviewed anglers did not catch any rainbow trout, brown trout, or walleye during the study

0.69 fish/hr. The overall black bass catch rate for the entire sampling period was 0.27 fish/hr.

Catch rates of black bass <12 in. in length and 12-15 in. in length were nearly identical during the summer and fall seasons (0.05 fish/hr, 0.06 fish/hr; Table 38). Catch rates for both size classes of black bass were much higher in fall in summer. Black bass >15 in. were caught at the same low rate (0.02 fish/hr) in summer and fall (Table 38).

Tournament anglers caught 12-15 in. black bass at the rate of 0.36 fish/hr (Table 39). Their catch rates of black bass <12 in. and >15 in. were significantly lower, 0.08 fish/hr and 0.07 fish/hr, respectively. Overall, black bass catch rate for tournament anglers was 0.43 fish/hour, 37% higher than that of nontournament anglers (Table 39).

Crappie

Anglers I interviewed only caught crappie on weekend days throughout the entire sampling period (Table 37). Weekend day catch rate of crappie was highest in spring (0.16 fish/hr), and declined in summer (0.02 fish/hr) and fall (0.04 fish/hr). Total catch rates of crappie were higher in spring (0.11 fish/hr) than in either summer (0.02 fish/hr) or fall (0.02 fish/hr). Overall crappie catch rate for the entire sampling period was 0.04 fish/hour (Table 37).

Sunfish

The summer and fall period comprised all of the sunfish caught during the study period. Sunfish catch rate was 0.28 fish/hr on weekend days during the summer, significantly higher than fall weekdays (0.07 fish/hr) or weekend days (0.09 fish/hr; Table 37). Total sunfish catch rate was highest in summer (0.27 fish/hr) and lower in fall (0.08 fish/hr) and spring (0.00 fish/hr). Overall sunfish catch rate for the entire sampling period was 0.18 fish/hr.

Table 38. Size class catch rate estimates (fish/hr) for black bass in the summer and fall seasons. Anglers were not asked to estimate size of their catch in the spring season. Catch rates include fish caught on weekdays and weekend days.

Size class	Summer	Fall
< 12 in.	0.05	0.32
12-15 in.	0.06	0.34
> 15 in.	0.02	0.02

Table 39. Estimates of black bass catch rates (fish/hr) and total catch for tournament anglers. Estimates include Monday and Friday night tournaments, and larger, sponsored tournaments (of which there were 3).

Size class	Tournament angler catch rate	Tournament angler catch
< 12 in.	0.08	515
12-15 in.	0.36	2,419
> 15 in.	0.07	458
Total[a]	0.43	2,944

[a]size class catch estimates do not equal total catch estimate because size data were not obtained for all fish caught. Catch rates do not add up to the total for the same reason.

Catfish

Anglers I interviewed caught catfish only on weekend days in spring and fall (Table 37). Highest catfish catch rate was on weekdays in summer (0.02 fish/hr), and on weekend days in fall (0.02 fish/hr). Total catfish catch rate was highest in summer and fall (0.01 fish/hr). Overall catfish catch rate for the entire sampling period was 0.01 fish/hour.

Total Estimated Catch

Black bass

Catch of black bass in spring was nearly equal on weekdays (586, 80% CI=245-827) and weekend days (580, 80% CI=230-930; Table 40). Anglers caught an estimated 955 (80% CI=720-1,190) black bass on weekend days in summer and 272 (80% CI=210-334) on weekdays. Catch of black bass on both weekdays (2,990, 80% CI=994-4,987) and weekend days (1,871, 80% CI=931-2,812) was highest in the fall season. Total catch of black bass was highest in fall at 4,861, followed by summer (1,227) and spring (1,166). Catch of black bass for the entire sampling period was 7,254 fish (Table 40).

The majority of black bass caught during the summer season were fish < 12 in. in length and 12-15 in. in length (Table 41). Twenty-one percent of the fish caught in summer were >15 in. Black bass <12 in. comprised 58% of the total catch in fall. Anglers caught 83 black bass >15 in. in fall., a 60% decline from summer estimates.

Tournament anglers caught an estimated 2,944 black bass (Table 39), and were most successful catching fish 12-15 in. in length. Anglers caught significantly fewer black bass < 12 in. in length (515) and > 15 in. in length (458). Size class catch estimates

Table 40. Total catch estimates for four fish species in Philpott Reservoir on weekdays and weekend days in each season. Eighty percent confidence interval is given in parenthesis.

	Day type		
Species[a]	Weekday	Weekend day	Total
	Spring (February 18-May 24)		
Black bass	586 (245-827)	580 (230-930)	1,166
Crappie	0 ----	346 (146-546)	346
Sunfish	0 ----	0 ----	0
Catfish	0 ----	12 (3-21)	12
	Summer (May 25-September 4)		
Black bass	272 (210-334)	955 (720-1,190)	1,227
Crappie	0 ----	104 (37-171)	104
Sunfish	1,156 (515-1,797)	1,817 (1,014-2,619)	2,973
Catfish	114 (66-161)	67 (3-132)	181
	Fall (September 5-November 31)		
Black bass	2,990 (994-4,987)	1,871 (931-2,812)	4,861
Crappie	0 ----	42 (0-90)	42
Sunfish	260 (0-644)	247 (66-428)	507
Catfish	0 ----	46 (13-79)	46

[a]interviewed anglers did not catch any rainbow trout, brown trout, or walleye during the study

Table 41. Total catch estimates by size class for black bass in the summer and fall seasons. Anglers were not asked to estimate size of their catch in the spring season. Estimates of total catch include fish caught on weekdays and weekend days. Eighty percent confidence interval is given in parentheses.

	Day type		
Size class	Weekdays	Weekend days	Total[a]
	Summer (May 25-September 4)		
< 12 in.	151 (78-224)	219 (132-307)	370
12-15 in.	59 (27-90)	345 (255-440)	404
> 15 in.	0 ----	207 (114-300)	207
Total	210	771	981
	Fall (September 5-December 31)		
< 12 in.	1,780 (571-2,989)	946 (376-1,515)	2,726
12-15 in.	1,056 (226-1,886)	862 (471-1,253)	1,918
> 15 in.	19 (0-129)	64 (12-116)	83
Total	2,855	1,872	4,727

[a]size class catch estimates do not always equal total catch estimate because size data were not obtained for all fish caught

do not sum to total estimated tournament angler black bass catch because size of catch data were not available for the larger, special tournaments.

Crappie

Anglers I interviewed only caught crappie on weekend days throughout the entire sampling period (Table 40). Weekend catch of crappie was highest in spring (346, 80% CI=146-546) and lower in summer (104, 80% CI=37-171) and fall (42, 80% CI=0-90). Anglers caught an estimated 346 crappie in the spring season, more than in summer and fall combined (Table 40). Overall crappie catch for the entire sampling period was 492 fish.

Sunfish

Anglers I interviewed only caught sunfish in the summer and fall periods (Table 40). Total estimated sunfish catch was much higher in summer (2,973) than in fall (507). Catch of sunfish was highest on weekend days in summer (1,817, 80% CI=1,014-2,619), and on weekdays in fall (260, 80% CI=0-644; Table 40). Overall sunfish catch for the entire sampling period was 3,480 fish.

Catfish

Anglers caught an estimated 12 catfish in spring, 181 in summer, and 46 in fall (Table 40). Catfish catch was lower in fall (85 (31-139) and spring (21 (6-37) (Table 40). Overall catfish catch for the entire sampling period was 239 fish, of which 76% were caught in summer.

Total Estimated Harvest

Black bass

Anglers harvested an estimated 9% of the black bass they caught (Table 42). However, the proportion of black bass harvested was much higher in spring than in summer or fall (Table 43). The proportion of black bass harvested declined in summer (5%) and fall (2%). Overall harvest of black bass for the entire sampling period was 650 fish.

Crappie

Overall crappie harvest for the entire sampling period was 197 fish, 40% of the estimated crappie catch (Table 42). Anglers I interviewed caught no crappie on weekdays in spring, summer, or fall (Table 43). Anglers harvested a higher proportion of crappie they caught in summer (67%) than in fall (37%; Table 43).

Sunfish

The summer season accounted for 100% of the total sunfish harvest (Table 43). Anglers harvested an estimated 22% (768) of the sunfish they caught (Table 42). Anglers we interviewed did not catch any sunfish in spring.

Catfish

Anglers harvested an estimated 11% (26) of the catfish they caught (Table 42). Harvest of catfish in spring and summer was zero fish (Table 43).

Table 42. Total estimated catch and harvest of black bass, crappie, sunfish, and catfish. Proportion of total estimated harvest to total estimated catch is also given. Estimates include weekdays and weekend days, and spring, summer, and fall.

Species	Total estimated catch	Total estimated harvest	Proportion harvested
Black bass	7,254	650	9%
Crappie	492	197	40%
Sunfish	3,480	768	22%
Catfish	239	48	20%

Table 43. Total harvest estimates for black bass, crappie, sunfish, and catfish in Philpott Reservoir for each season. Estimates include fish harvested on weekdays and weekend days. Eighty percent confidence intervals are given in parentheses.

	Day type		
Species[a]	Weekday	Weekend day	Total
	Spring (February 18-May 24)		
Black bass	102 (56-147)	368 (79-657)	470
Crappie	0 ----	127 (27-226)	127
Sunfish	0 ----	0 ----	0
Catfish	0 ----	0 ----	0
	Summer (May 25-September 4)		
Black bass	0 ----	62 (24-101)	62
Crappie	0 ----	70 (22-118)	70
Sunfish	0 ----	768 (148-1,387)	768
Catfish	0 ----	0 ----	0
	Fall (September 5-November 31)		
Black bass	118 (8-227)	0 ----	118
Crappie	0 ----	0 ----	0
Sunfish	0 ----	0 ----	0
Catfish	0 ----	26 (0-57)	26

[a]interviewed anglers did not catch any rainbow trout, brown trout, or walleye during the study

DISCUSSION

Smith River

Angler effort on the Smith River is moderate relative to other tailwater trout fisheries in the southeast. I compared total angler effort from the spring and summer periods on the Smith River to a comparable six month period (April-September, 1995) surveyed by researchers on four Tennessee tailwater trout fisheries: the Caney Fork River, Obey River, Duck River, and Elk River. Effort per km on the Smith River (1,171angler-hours/km) was significantly higher than the Elk River (652 angler-hours/km; Bettoli & Besler 1996), and slightly higher than the Duck River (1,143 angler-hours/km; Bettoli[a], 1996). The Caney River (3,727 angler-hours/km; Bettoli & Xenakis 1996) and the Obey River (4,661 angler-hours/km; Bettoli[b] 1996) both received more intense angling pressure than the Smith River. All four Tennessee rivers were stocked with both catchable size rainbow trout and brown trout during the study period.

Comparisons of total angler effort among river sections is best done when taking into account the length of the section, relative to the amount of effort it received. The lower section received highest overall use during the study, but had the lowest amount of effort per river km. The importance of the middle section on total angler effort is more apparent when I standardized effort estimates. The middle section received the second highest amount of use per river km of any section, and had the highest concentration of effort on weekend days. Access in the middle section also limits anglers to the upper half of the section, unless anglers hiked a considerable distance to the river. The lower end of the middle section provided another access point in this section. However I observed few anglers accessing the river at this point. Private property along both river banks at the lower end of the middle section precluded anglers from hiking farther up into the section by land.

Flows also play an important role in patterns of angler use in the middle section. Since the majority of anglers in this section were fly fishers who waded the stream, higher flows made it difficult or impossible to fish during periods of generation. The middle section showed the most dramatic difference in weekday effort on days when generation occurred versus days on which it did not. Anglers in this section generally travel a longer distance to fish than anglers in either the upper or lower sections. They have much time invested in their fishing trip, and do not want to be interrupted by high flows. Therefore anglers in this section chose not to fish when flows were high.

Angler effort was highest in the upper section, as was effort per km. Anglers probably chose to fish this section more due to its ease of access, many fishing spots, and lack of development along the river. The USCOE provides parking areas immediately below the dam, which makes this spot a popular fishing hole for many anglers. Some of the access points provide anglers with a safe place to fish during periods of generation. Many anglers began their fishing day in the upper section, and would move downstream as the day progressed, especially if power generation began. Length of the lower section, along with its many access points, may explain the high effort in this section. However, commercial development along the river exists throughout the lower section, which may make it a less desirable fishing location for some anglers. High flows do not seem to influence angler use during the week in the lower section. This may be explained by the fact that many anglers who fish this section live close by, and have a short trip home if water levels rise. Anglers in the lower section also tend to fish from the bank using bait more than in the other two sections. Bait angling was affected less by high flows than lure or fly angling.

Catch rates for rainbow trout on the Smith River (0.26 fish/hr) were lower than those of four Tennessee tailwater trout fisheries. The Caney Fork River (1.03 fish/hr; Bettoli & Senakis 1996), Obey River (0.96 fish/hr; Bettoli[b] 1996), Duck River (0.55 fish/hr; Bettoli[a] 1996), and the Elk River (0.78 fish/hr; Bettoli & Besler 1996) all had higher catch rates than the Smith River. This was not the case for brown trout, however. Catch rate for brown trout on the Smith River (0.20 fish/hr) was significantly higher than that of the Caney Fork River (0.06 fish/hr), Obey River (0.07 fish/hr), slightly lower than the Duck River (0.29 fish/hr), and more than half that of the Elk River (0.517 fish/hr). The total trout catch rate for the Smith River was 0.46 fish/hr, which is less than the total trout catch rate for four Tennessee Rivers. However, brown trout were stocked in all four Tennessee rivers, a management option not practiced by VDGIF on the Smith River. In addition, the Tennessee Wildlife Resources Agency also stocked significantly more rainbow trout in the Caney Fork (108,830), Obey (101,565, and Elk (49,923) rivers. The Duck River was stocked with only 31,004 catchable size rainbow trout, similar to the 32,350 trout VDGIF stocked in the Smith River in 1995.

Catch rate of rainbow trout on weekdays in the lower section during the spring season was inflated due to my small sample size and due to two anglers achieving unusually high success. Catch rates in the lower section were much lower during the summer and fall seasons. Catch rates of rainbow trout declined from spring to summer, and increased from summer to fall, in both the upper and middle sections. Lower catch rates in summer may be related to the lack of stocking during the summer months. The last stocking date was May 30 and did not resume until October 3. The lower section had the highest overall catch rate of rainbow trout, which may be a result of anglers using methods geared toward catching stocked fish in this section, such as bait fishing.

Brown trout catch rates were highest in the middle section, not a surprising result given this section was not stocked with rainbow trout and most anglers fished this section to catch wild brown trout. Anglers were most successful catching brown trout in fall in the middle section. Brown trout are most vulnerable during this time as they prepare to spawn. Surprisingly, the upper section also had a high catch rate of brown trout. Anglers in the upper section tended to be more specialized in their gear and many fished this section to catch brown trout. VDGIF electrofishing efforts in this section show a relatively large concentration of brown trout, which may contribute to the high catch rate.

Anglers who fished on opening day of trout season were most successful catching stocked rainbow trout in the upper and lower sections. Catch rate of rainbow trout on opening day was more than twice as high as total catch rate in spring in the upper section. Anglers in the lower section caught rainbow trout on opening day at the same rate as the total catch rate for the spring season.

The estimate of rainbow trout caught and harvested in the lower section on weekdays during the spring season was inflated, due to small sample size and unusually high success of two anglers. VDGIF stocked 22,000 rainbow trout in the lower section of the Smith River in 1995. The estimate of total catch in the lower section was 91% of the total number of fish VDGIF stocked, a very high proportion. Conversely, anglers in the upper section caught only 25% of the 10,350 rainbow trout VDGIF stocked in the upper section, while receiving 3 times the angling pressure of the lower section.

Anglers in the upper and lower sections harvested a much higher proportion of rainbow trout they caught compared to brown trout. Harvest of brown trout may have been lower than harvest of rainbow trout because the brown trout on average tended to be smaller than rainbow trout. Anglers fishing the middle section rarely harvested fish, and usually only did so when it appeared a caught fish would die soon after release. They did not harvest any brown trout during the entire sampling period.

I chose the roving survey design as my angler contact method because I felt this method would best suit sampling on the Smith River. Due to many access points in the upper and lower sections, the bus route design is another survey design I could have used. Even though the bus route method works well when many access points exist, I could not establish defined access points along the river at which bus route stops could be made. Interviewing anglers from each bus stop would be difficult because a clear view of the river was not always possible. The roving design allowed me to drive along the river and search out anglers, rather than waiting for them to come to us.

Using instantaneous counts provided the best method to estimate angler use on the Smith River. Since counts in each section could be completed in roughly one-half hour, I could maximize time spent conducting interviews using the roving survey design. Other methods, such as expansion of car counts, would be difficult because a parked car did not always signify an angler in the highly developed lower section. I needed to have the option to get out of the car and search the river if a parked car was encountered along the angler count route. I applied a roving-access design in the middle section because one defined access point existed and nearly all anglers used it to access the middle section.

One method I could have used to increase the number of interviews would have been to conduct incomplete interviews from the outset of the project. I began conducting incomplete interviews after the spring season when I realized low interview numbers may be a problem. A second way to increase the number of angler interviews in the future would be to concentrate sampling efforts on days or half-days when power generation did not occur. I did not do this during this project because I needed information on flows and how they affected angler use patterns, so I needed to sample during periods of generation. A problem with scheduling sampling days around power generation is the generation schedule is usually only determined one week in advance, and sometimes changed without notice. I interviewed fewer anglers than I had anticipated before the project started (34-upper section; 76-middle section; 33-lower section; 88 total on opening day), not as a result of low sampling effort, but rather because fewer anglers fished the Smith River than originally anticipated.

Philpott Reservoir

The most recent creel survey conducted on Philpott Reservoir resulted in an estimate of total angler effort from March through December of 62,839 angler-hours (53.9 hrs/ha; Whitehurst 1981). Using instantaneous angler counts, I estimated angler effort to be 63,186 angler-hours (54.2 hrs/ha), almost exactly the same effort as 15 years previously. Whitehurst estimated angler effort using aerial surveys in 1977 at 71,502 angler-hours (61.3 hrs/ha). Angler effort per area on Philpott Reservoir is similar to effort estimates on Smith Mountain Lake and Lake Moomaw. Daytime angler effort was estimated at 50.0 angler-hours/ha on Smith Mountain Lake from March 1, 1992-December 31, 1992 (Duval 1992). Angler effort on Lake Moomaw was slightly higher during roughly the same time period (57.60 angler-hours/ha). Fishing pressure on Claytor Lake, Virginia during 1992 was estimated at 90.3 angler-hours/ha (Southwick 1992). Lake Anna, Virginia experienced even more intense angler pressure during 1993 (108 angler-hours/ha; Odenkirk 1993).

I was not able to assess angler effort at night. I interviewed many anglers who regularly fished Philpott Reservoir and was told night angling is very popular during the warmer months due to high pleasure boat activity during daylight hours. In future creel studies of Philpott Reservoir, attempts should be made to quantify angler effort at night.

Prior to the study, VDGIF personnel hypothesized that a spring walleye fishery existed in the upper Smith River and Runnett Bag Creek arms of Philpott Reservoir. However, I did not interview any anglers in the upper section who were targeting walleye. Many anglers fished the upper section in search of crappie in spring, but not for walleye. However, angler effort in the upper section during the spring was high, especially considering this section is small compared to the much larger middle and lower sections.

Angler effort in the lower and middle sections was nearly equal. I stratified angler effort estimates by section because angler counts on the entire reservoir could not be completed in less than one hour. Differences in angler effort on weekdays and weekend days were more significant. Angler effort in the spring season was nearly the same on weekdays and weekend days, however during the summer, most effort occurred on weekend days. This is somewhat surprising given the high amount of use by pleasure boaters and personal watercraft operators during the summer season. I observed many anglers fishing in the back of coves on busy weekends in an effort to avoid congestion on the main lake. One explanation for high effort on weekend summer days is weekends are generally the time when people have free time to fish or take a vacation.

Bank angler effort comprised only a small percentage of total angler effort in any season. The majority of bank angler effort occurred in summer around USCOE campgrounds, and was almost nonexistent when the campgrounds closed on October 1. Bank angler effort was also low in spring before the campgrounds opened on April 1, and generally remained low until the weather warmed.

Whitehurst (1981) also estimated catch rates for all the major fish species in Philpott Reservoir. Catch rates for largemouth bass and smallmouth bass were 0.03 fish/hr and 0.04 fish/hr, respectively. In comparison, I estimated a black bass catch rate of 0.27

fish/hr, considerably higher than the 1981 estimate. Catch rate was highest for black bass in the fall season, a time when anglers I interviewed reported that black bass are generally easy to catch. Surprisingly, black bass catch rates were lowest in spring during the spawning season. Anglers fishing Lake Anna during 1993 were less successful in catching largemouth bass, catching only 0.014 fish/hr (Odenkirk 1993). The most recent (1992) black bass catch rate for Smith Mountain Lake is 0.31 fish/hr (Duval 1992).

Tournament anglers had a higher catch rate for black bass than nontournament anglers. This may be a result of more intense and skilled fishing efforts. Most of the anglers who fished in the Monday night and Friday night tournaments did so on a regular basis and were very familiar with many patterns which could be used to successfully catch black bass. Both tournament and nontournament anglers were most successful catching black bass 12-15 in. in length, as were nontournament anglers. However, tournament angler catch rates were much higher than nontournament angler catch rates.

Whitehurst (1981) also estimated catch rate for crappie (0.02 fish/hr), similar to the catch rate I estimated for crappie (0.04 fish/hr). Catch rates for bluegill and redbreast sunfish were 0.02 fish/hr and 0.003 fish/hr, respectively (Whitehurst 1981). I did not estimate catch rates for individual sunfish species. Overall sunfish catch rate in 1995 was 0.18 fish/hr. Whitehurst (1981) also estimated separate catch rates for white catfish (0.002 fish/hr) and channel catfish (0.008 fish/hr), whereas I calculated one catfish catch rate. In comparison, I estimated a catfish catch rate of 0.01 fish/hr.

Anglers I interviewed did not catch any rainbow trout, brown trout, or walleye, nor did I interview any anglers who were targeting these species. It was somewhat surprising that I did not interview any anglers who were targeting walleye or trout since VDGIF has stocked walleye since 1976 and rainbow trout and brown trout since

1977. Whitehurst (1981) also did not interview any anglers who caught brown or rainbow trout, and he estimated a walleye catch rate of only 0.0007 fish/hr.

Whitehurst (1981) also estimated total catch for the primary species in Philpott Reservoir. Anglers caught an estimated 4,944 black bass, from March 1 through December 31, 1981. I estimated black bass catch at 7,254 fish, a significant increase from Whitehurst's (1981) estimate. Whitehurst (1981) estimated black bass harvest at 3,420 fish, whereas I estimated black bass harvest at 650 fish, an 81% decrease. Anglers harvested only 9% of black bass they caught during this study, compared to an estimate of 70% by Whitehurst in 1981. Anglers harvested only 5% of the black bass they caught on Smith Mountain Lake in 1992 (Duval 1992), and 11% on Lake Anna in 1993 (Odenkirk 1993). Eighteen percent of the black bass caught were harvested by anglers fishing Lake Moomaw in 1992 (Bugas 1992). Anglers harvested a high proportion (40%) of crappie they caught in Philpott Reservoir in 1995. I estimated a lower crappie total catch (492) than Whitehurst (1981; 1,418 fish). Anglers harvested 94% of the crappie they caught in Lake Moomaw in 1992 (Bugas 1992).

I used a roving-access design to conduct angler interviews at Philpott Reservoir. This method worked very well to intercept anglers and conduct angler counts. I could have used other methods, such as the bus route, to obtain angler interviews but they may not have been as effective as the roving-access design. The bus route method was another method I could have used to obtain angler interviews. The seven interview locations would have served well as bus stops along a sampling route. If this method were used in future creel studies on Philpott Reservoir, the sampling route should be traveled by boat to cut down on travel time. Conducting instantaneous angler counts by driving a boat proved to be a very efficient way to gather angler count and recreational user count data. Aerial counts would have been a second method I could have used to gather angler count data, but I could not have conducted as many counts, was more expensive, and dependent on favorable weather conditions. Counting boat trailers at various boat ramps was another method available, but due to heavy recreational use at Philpott, especially during the summer, it would be difficult to determine if trailers signified anglers or recreational users.

I obtained 166 interviews during the course of the study. In the future changes could be made to increase interview numbers. For example, assigning different probabilities to the morning and evening period would allow more sampling effort during periods of higher angler activity. From my experience at Philpott Reservoir, the majority of anglers fished in the evening hours. A second way to possibly increase interview numbers would be to set the sampling day from one hour after sunrise to one hour after sunset, instead of from sunrise to sunset. I interviewed only 42 anglers (25%) during the morning period, obtaining the majority of interviews in the evening period (124), and on days when I stayed after dark.

Using the USCOE car count data to determine which boat ramps received highest use proved to be a good way to assign random number categories to each access point. However, bank anglers were under represented. In the future, time should be scheduled during which creel clerks specifically work campgrounds to interview bank anglers during the warm months of the year.

CHAPTER 2

Net Economic Value of the Smith River and Philpott Reservoir Fisheries

INTRODUCTION

Creel surveys may be used for social and economic purposes in addition to biological purposes. Economic questions are increasingly incorporated into angler interview instruments. Placing a dollar value on a recreational experience, such as fishing, is difficult because there is no true market for the experience, and total value is more than expenditures for the trip. Total use value includes expenditures plus the value over and above what users actually spent on their trip. Total economic value also includes nonuse values, such as existence value, option value, and bequest value.

The two most common methods used for estimating net economic value (the portion of use value in excess of expenditures) are the travel cost method (TCM) and contingent valuation method (CVM; Pollock et al. 1994). The TCM, which is site-specific, bases net economic value on actual angler behavior using travel costs as a proxy for price (Pollock et al. 1994). The question of how to include cost of travel time in total travel expenses has been frequently debated (Knetsch and Cesario 1970, McConnell and Strand 1981, Hof and Rosenthal 1987). The effects of other resources as possible substitutes should also be considered when using the TCM (Moss and Lamphear 1970). Data needed for TCM analysis include travel expenses (gas, lodging, food, etc.), distance traveled from home to the recreational site, and type of transportation used (car, truck, van).

There are two widely accepted methods of estimating net economic value using the TCM. The first is a zonal method, which uses cities, counties or concentric rings of equal distance as population zones. The second is an individual approach, where individual or household data are used, rather than grouping users by zones (AFS 1992).

The CVM can be used to evaluate management alternatives or fishing scenarios. For example, an increase in minimum flows can be valued (Duffield et al. 1994). The CVM estimates net economic value directly by asking anglers to quantify their willingness to pay. Hypothetical situations are presented to anglers and they are asked the maximum they would pay for the described situation, above what they have already paid. The CVM assumes anglers can accurately assign value to hypothetical situations (Adamowicz and Phillips 1983). Critics of the method point to its hypothetical nature (Cummings et al. 1986). However, other researchers have provided empirical evidence demonstrating agreement between CVM results and those of a real market (Bishop and Heberlein 1979, Bishop et al. 1983, Bohm 1972). Strategic bias may exist if respondents give artificially high or low willingness to pay values because they believe it is in their best interest to do so (Pollock et al. 1994).

Method of payment bias also can be problematic, and choosing a payment vehicle is an important part of formulating willingness to pay questions (Mitchell and Carson 1989). The CVM involves describing a situation, and then asking an angler to state his or her willingness to pay for the situation described. Method of payment may take the form of increased license fees, taxes, or additional travel costs. If an increase in taxes is chosen as a payment vehicle, anglers may give artificially low willingness to pay values because of the negative connotations associated with taxes (Pollock et al. 1994). I chose travel expenses as a method of payment for my willingness to pay questions.

Researchers have used a variety of methods to elicit willingness to pay values. The continuous method, often referred to as a bidding game, presents increasingly higher dollar values until the respondent agrees to a maximum value he or she would pay.

An open ended method is one where the respondent writes in or answers any amount. The method is considered difficult due to respondents being able to accurately assign willingness to pay values. Another alternative, the dichotomous choice method, presents a dollar value randomly selected from a specified range (AFS 1993). The respondent answers yes if they are willing to pay at least the stated amount, and no if they are not. Many researchers favor the latter method because it mimics more closely how goods are bought by consumers. A third method, known as the payment card, elicits willingness to pay by asking subjects to select from a range of dollar values. Willingness to pay values are regressed against explanatory variables such as characteristics of the good being valued, income and age. Mean willingness to pay values are aggregated to estimate net economic benefit.

Both the TCM and CVM have methodology limitations and benefits. Due to flexibility, the CVM can be used in almost any situation. The TCM is most precise when estimating net economic value of one resource, and when use of the resource is the sole purpose for the trip. A common approach taken by many researchers is to use both the TCM and CVM, and to compare net benefit estimates from each (Smith et al. 1986). This chapter will address objectives #3 and #6 listed in the Introduction of Chapter 1. I will estimate economic value of the Smith River and Philpott Reservoir fisheries, under current fishing conditions and under alternative fishing scenarios. Furthermore, economic value and tradeoffs associated with an alternative flow regime for the Smith River are presented.

METHODS

Estimating Net Economic Value

I used both the CVM and TCM to estimate net economic value. I asked questions 11-15 (Figure 8) to generate the data necessary to estimate net economic benefits using the TCM. Questions 19-24 (Figure 8) and 19-22 (Figure 9) on the interview form are designed to estimate economic benefits using the CVM. I chose the use the payment card method using travel expenses as a method of payment for the willingness to pay questions.

Travel Cost Method

The first of several steps in developing a TCM estimate of economic value is to generate a per capita first stage demand curve for each of the three river sections using a zonal approach with counties as distance zones, following examples in Pollock et al. (1994). The per capita demand curve and population data were used to generate an aggregate site demand curve. Time cost of travel is usually calculated as a proportion of the wage rate for a distance zone. Cesario (1976) estimated cost of travel time to be between 25% and 50% of the wage rate. The area under the demand curve, over and above what anglers have already paid, is net economic value.

Creating the first stage demand curve

I eliminated counties which were represented by only one angler, and counties that were located farther from the resource than 95% of all the other counties (of which I had 2), in order to eliminate outliers (Pollock et al. 1994). I obtained county population data from the 1990 United States Census. In Virginia, where independent cities

Figure 8. Smith River interview form.

Smith River Angler Interview Form

"Hello, my name is____and I'm doing a survey for the Virginia Department of Game and Inland Fisheries to determine why fishermen decide to fish the Smith river and to determine the economic value of the trout fishery. Do you mind if I ask you some questions about your fishing trip today?" (If no, say thank you and leave.)

Date______ID #_______ Initials______ Interview start time_____ Weather__________

River section______(1, 2, 3) # in party____Male___Female__Incomplete trip_______

Fishing from: shore_____wading___boat___Current river condition_________________

Gear type (check all that apply): spinning____ bait____ lure___ fly____

Guided trip: yes_____ no_

1.) What time did you start fishing today? _____When did you stop fishing today?____

	brown	rainbow	other
2.) What species of fish are you fishing for?	_______	_______	___
3.) How many fish have you caught today?	_______	_______	___

4.) How many brown trout have you released that were: <10in___10-16in___>16in___

5.) How many rainbow trout have you released that were: <10in___10-16in___>16in___

"I would now like to ask you some questions concerning other places you like to fish, and how flows in the Smith River influence when you fish at these places."

6.) Have you fished any of your other favorite fishing spots within the last 3 months when you wanted to fish the Smith but couldn't because of high flow? yes_____ no_____

how many times has this happened in the last 3 months?____

7.) Have you not fished the Smith at all because of high flow? yes____ no_

8.) If high flows had prevented you from fishing the Smith today, would you have fished elsewhere?

yes______ no_____ **if yes**, where?________________________________

9.) Does flow influence whether you fish on weekdays or weekends? yes_____ no____

10.) How satisfied are you with the current flow patterns?

____very satisfied____satisfied___neutral___dissatisfied_____very dissatisfied

a. **If not satisfied**, how could the situation be improved? __________________

b. did you know the flow conditions before you came to fish today? yes___no____

Figure 8. Smith River interview form (continued).

"The next few questions deal with how much money you have spent on this trip and the value you place on fishing the Smith River."

11.) How many miles did you travel one way from your home to the Smith River?______

12.) How much time did you spend traveling from your home to the River?___hrs ___min

13.) What type of transportation did you use to get here? car__ truck_____ 4WD___

Van_____ other________

14.) Is fishing the Smith River the primary purpose for your trip? yes__ no___

15.) How many days is your trip? (circle) 1 2 3 >3 (specify)______

16.) Including today, how many times have you fished the River in the last year?____

17.) How much did you spend on this trip for each of the following items?
oil, gas, etc., $_______ lodging $___ food/drink $______
other (e.g., equipment-for this trip only)__________

18.) What percentage did you spend in the local area?_______

"On this card are dollar values you will choose from to designate your willingness to pay for certain fishing conditions I will describe. After each situation, please choose a dollar value from the card, or choose "other" to designate a value not on the card."

19.) How much more above your current travel expenses would you be willing to pay for current fishing conditions? $_____

20.) How much more above your current travel expenses would you be willing to pay if you were twice as likely to catch a daily bag limit of trout--brown or rainbow? $____

21.) How much more above your current travel expenses would you be willing to pay if you were twice as likely to catch a wild brown trout? $_______

22.) How much more above your current travel expenses would you be willing to pay if you were twice as likely to catch a trout larger than 16 inches--brown or rainbow? $______

23.) How much more above your current travel expenses would you be willing to pay if flow patterns were more predictable? $_____

24.) How much more above your current travel expenses would you be willing to pay if you did not have to stop fishing or cancel a trip due to high flows? $_______

Figure 8. Smith River interview form (continued).

"On the next card is a list of factors that may have influenced your decision to fish here. Please rank, in order, your first, second, and third most important factors."

25.) Which factors were most important in your choosing to fish the Smith River today?

a.) opp. to catch lots of fish	____	e.) to test my fishing skills	____	i.) to view the scenery	____
b.) opp. to catch wild trout	____	f.) I've had success here before	____	j.) for the solitude	____
c.) opp. to catch stocked fish	____	g) where my friends were going	____	k.) close to home	____
d.) opp. to catch a trophy fish	____	h.) to be with friends or family	____	l.) to catch fish to eat	____
				m.) other	____________

"I would now like to ask you questions concerning fishing regulations and your attitude towards management practices (next card). You will not incriminate yourself if you don't know the regulations."

26.) What is the: daily bag limit? yes___ no___ size limit? yes____ no____ lure restrictions? yes____ no_

27.) Please assign a number value to each of the following areas that VDGIF management efforts should be directed. 1=low effort, 5=high effort

a.) stocking	1	2	3	4	5
b.) flow management	1	2	3	4	5
c.) fishing regulations	1	2	3	4	5
d.) increased access (parking, trails, etc.)	1	2	3	4	5
e.) other ______________________	1	2	3	4	5

- Which of the above management options is most important to you? (circle the letter of the most important) None______

"I would like to conclude the interview by asking a few more questions which will allow us to characterize river users. Please designate the letter on the next card that best represents your total household income last year before taxes."

28.) Total household income last year before taxes.

a.) <19,999 ____	b.) 20,000-34,999____	c.) 35,000-54,999_____
d.) 55,000-79,999 ____	e.) >80,000 ____	f.) no response _____

29.) What is the highest educational level you have completed?

1 2 3 4 5 6 7 8	9 10 11 12			
elementary	high school	some college	bachelors degree	graduate studies

30.) What is your age?_____

31.) Are you a member of a fishing or conservation or environmental organization? No___
TU_____ FFF___ Audubon Society ________ Other ___________

32.) Where do you presently live? town________county__________state______zip code_________

Figure 8. Smith River interview form (continued).

"Do you mind if I measure the fish you have caught today?"

FISH MEASUREMENT

Species	Length	1	2	3	4	5	6
brown							
rainbow							
other							

33.) Are there any comments you would like to make regarding VDGIF management of the Smith River?____

____

34.) Would you be interested in participating in a follow-up mail survey? yes____no___
(if yes have them fill out name and address on notochord)

Interview ending time: __________

Figure 9. Philpott interview form.

Philpott Reservoir Angler Interview Form

"Hello, my name is______and I'm doing a survey for the Virginia Department of Game and Inland Fisheries to determine why fishermen decide to fish Philpott Reservoir and the economic value of the fishery. Do you mind if I ask you some questions about your fishing trip today?" (If no, say thank you and leave.)

Date________ ID #___ Initials______ Interview start time__________

Reservoir section_______(1, 2, 3) # in party___ Male____ Female_____ Night___

Fishing from: shore____ boat__ Weather_______________________

Gear type (check all that apply):bait____lure___trolling____Guided trip:yes___no___

1.) What time did you start fishing today? _____When did you stop fishing today?_____

	BT	RBT	WE	SMB	LMB	CP	SF	CAT	Any
2.) What kind of fish are you fishing for?	__	___	__	___	___	__	__	___	___
3.) How many fish have you caught today?	__	___	__	___	___	__	__	___	___
4.) How many fish have you released today	__	___	__	___	___	__	__	___	___

5.) How many smallmouth have you released that were: <12in____12-15in___>15in____

6.) How many largemouth have you released that were: <12in____12-15in___>15in____

7.) How many walleye have you released that were: <12in____12-18in___>18in____

8.) How many brown trout have you released that were: <10in____10-16in___>16in____

9.) How many rainbow trout have you released that were:<10in____10-16in___>16in____

"I would now like to ask you questions concerning fishing regulations. You will not incriminate yourself if you do not know the regulations."

10.) What are the daily bag and size limits for:

			bag limit	size limit
5 per day (comb.)--12" min.	a.)	black bass (LMB, SMB)	yes__no__	yes___no___
8 per day	b.)	walleye	yes__no__	
2 per day --16" min.	c.)	trout	yes__no__	yes___no___
25 per day	d.)	crappie	yes__no__	

"The next few questions deal with how much money you have spent on this trip and the value you place on fishing Philpott Reservoir."

11.) How many miles did you travel one way from your home to Philpott Reservoir?______

12.) How much time did you spend traveling from your home to Philpott?____hrs ___min

13.) What type of transportation did you use to get here?

car___truck____ 4WD___van____other___

Figure 9. Philpott interview form (continued).

14.) Is fishing Philpott Reservoir the primary purpose for your trip? yes____ no__

15.) How many days is your trip? (circle) 1 2 3 >3 (specify)______

16.) Including today, how many times have you fished Philpott in the last 12 months? __

17.) How much did you spend on this trip for each of the following items?

oil, gas, etc., $________ lodging $__ food/drink $________ other (e.g., equipment-for this trip only)_____

18.) What percentage did you spend in the local area?________

"On this card are dollar values you will choose from to designate your willingness to pay for certain fishing conditions I will describe. After each situation, please choose a dollar value from the card, or choose "other" to designate a value not on the card."

19.) How much more above your current travel expenses would you be willing to pay for current fishing conditions? $______

20.) How much more above your current travel expenses would you be willing to pay if you were twice as likely to catch a brown or rainbow trout? $__________

21.) How much more above your current travel expenses would you be willing to pay if you were twice as likely to catch a walleye?$_______

22.) How much more above your current travel expenses would you be willing to pay if you were twice as likely to catch a large or smallmouth bass? $__________

"On the next card is a list of factors that may have influenced your decision to fish here. Please rank, in order, your first, second, and third most important factors."

23.) Which factors were most important in your choosing to fish Philpott Reservoir today?

a.) opp. to catch lots of fish	_____	e.) to test my fishing skills	______	i.) to view the scenery	_____
b.) opp. to catch wild trout	_____	f.) I've had success here before	______	j.) for the solitude	_____
c.) opp. to catch stocked fish	_____	g) where my friends were going	______	k.) close to home	_____
d.) opp. to catch a trophy fish	_____	h.) to be with friends or family	______	l.) to catch fish to eat	_____
				m.) other	________________

"On the next card are areas the department would like to receive input on from anglers. Please assign a 1-5 value corresponding to level of management effort you feel each area should receive."

24.) Please assign a number value to each of the following areas corresponding to level of management effort. 1=low effort. 5=high

a.) stocking	1	2	3	4	5
b.) water level management	1	2	3	4	5
c.) fishing regulations	1	2	3	4	5
d.) increased access (parking, trails, etc.)	1	2	3	4	5
e.) law enforcement	1	2	3	4	5
f.) fish habitat enhancement	1	2	3	4	5
g.) other ______________________________	1	2	3	4	5

- Which of the above management options is most important to you? (circle)None_____

Figure 9. Philpott interview form (continued).

"I would like to conclude the interview by asking a few more questions which will allow us to characterize reservoir users. Please designate the letter on the next card that best represents your total household income last year before taxes."

25.) Total household income last year before taxes.

a.) <19,999 ____ b.) 20,000-34,999____ c.) 35,000-54,999_____

d.) 55,000-79,999 ____ e.) >80,000 ____ f.) no response _____

26.) What is the highest educational level you have completed?

1 2 3 4 5 6 7 8 — elementary; 9 10 11 12 — high school; some college; bachelors degree; graduate studies

27.) What is your age?_____

28.) Are you a member of a fishing or environmental organization? No_____
BASS____ Local bass club (name) ____________________ other________

29.) Where do you presently live? town________(or) county__________state_____ zip code_____

"Do you mind if I measure the fish you have caught today?"

FISH MEASUREMENT

Species	Length	Weight	Species	Length	Weight	Species	Length	Weight

30.) Are there any comments you would like to make regarding VDGIF management of Philpott Reservoir?____

31.) Would you be interested in participating in a follow-up mail survey?
yes______ no____ (if yes, have them fill out name and address on notecard)

Interview ending time: ____________

are listed separately from counties, I added the population of the independent city to the county population. I multiplied the proportion of anglers I interviewed from each county by the total number of angler days for the sampling period to estimate angler days per county and per capita visitation (Equation 2.1). The first stage demand curve plots per capita visitation rate against distance.

$$PCVR = AAD/CP \qquad \text{Equation 2.1}$$

where:

PCVR = per capita visitation rate

AAD = annual angler days

CP = county population

The second stage demand curve plots total visits against added cost. Total visits are predicted from the regression equation derived from the first stage demand curve and census data. Added cost is a conversion of distance and travel time to total travel costs.

Estimating cost of travel

Once I completed the above steps, I converted the additional travel distance to dollars, which allowed me to estimate net economic value. The cost of travel is comprised of two components: 1) vehicle cost of travel, and 2) time cost of travel. I standardized the vehicle cost of travel by individual anglers by dividing a mileage cost/mile ($0.31/mile; US Department of Revenue 1997) by the average party size for each river section (Equation 2.2).

$$VCT = 0.31/APS \qquad \text{Equation 2.2}$$

where:

VCT = vehicle cost of travel

APS = average party size

Estimating time cost of travel required the following information: 1) average round trip miles an angler traveled from his home to the resource; 2) average hourly wage rate, and 3) average vehicle speed (mph). I obtained mileage information from on-site interviews. Researchers have used many different proportions of the wage rate for the travel cost method, ranging from .25 (Cesario 1976) to .35 (Weithman and Haas 1982) to .60 (McConnel and Strand 1981). I chose to use 0.25 because it allowed me to make a conservative estimate of the value of travel time, and of net economic value. To estimate .25 of the wage rate, I averaged the midpoints of the income categories, divided by 2,080 hours (52 weeks times 40 hours/week) and then multiplied by .25. I used 45 mph as an average vehicle speed (Pollock et al. 1994). I used equation 2.3 to estimate the time cost of travel.

$$TCT = (MT)(.25\ WR)/\ 45\ \text{mph} \qquad \text{Equation 2.3}$$

where:

TCT = time cost of travel

MT = round trip miles traveled (or additional round trip miles)

WR = average hourly wage rate

I used equations 2.2 and 2.3 to estimate the vehicle cost of travel and time cost of travel for each of the additional round trip mileage increments.

I estimated consumer surplus by finding the area under the demand curve shown in Figure 10. To find the area under the curve I first fit a linear regression line to the data shown in Figure 10, solved for total visits (TV), integrated the regression equation and then inserted the value of TV back into the integrated equation. Consumer surplus is equal to the area under the regression line fit to the data shown in Figure 10.

Contingent Valuation Method

I asked anglers a series of questions which proposed different fishing scenarios. Anglers chose a dollar value from the payment card to indicate how much they would be willing to pay in increased travel expenses, such as fuel and food for each proposed scenario. The payment card used for both Philpott Reservoir and the Smith River included 20 different dollar values ranging from $0 to $500.00, and an option to write in another dollar amount. I chose 20 dollar values to provide anglers with a wide range to chose from. I assumed few, if any, anglers would be willing to pay an additional $500.00 in travel expenses to fish at Philpott Reservoir or the Smith River, thus driving the demand curve to zero.

I generated a model containing variables that predicted an angler's willingness to pay for a given fishing scenario using regression analysis. Only statistically significant predictors were used as independent variables. Two commonly used methods to generate a regression equation for payment card date include simple linear regression and censored regression. Censored regression takes into account that an angler's choice from the payment card represents an interval between the next lower value and the next higher value. The result of censored regression analysis is an equation containing significant variables that can be used to predict willingness to pay for a given fishing condition.

To begin the modeling process, I selected all variables that were theoretically expected to impact willingness to pay. I then performed correlation analysis to remove all perfectly correlated variables, because no regression will accept perfectly correlated independent variables. I generated a number of models using an iterative process. The final model contained only statistically significant variables at alpha=0.10, and variables that were thought to be critically important in explaining willingness to pay.

I used a log transformation of income in an attempt to produce a better fitting model. When I asked anglers their total combined income before taxes, I presented them with a card containing a series of income intervals (Figure 8, question 28; Figure 9, question 25). I used the midpoint of each income interval.

According to economic theory, income should be a significant variable in each model to predict an angler's willingness to pay, because as a person's income increases, he or she should be willing to pay more for the good in question, in this case a fishing experience (provided a fishing experience is a normal good). However, income was a significant variable in only 4 of 18 predictive models.

Calculating net economic value and total economic value

I calculated net economic value (Equation 2.4) for each fishing scenario by multiplying mean willingness to pay by the total number of angler days (Equation 2.5).

$$NEV = (PWTP)(AD) \qquad \text{(Equation 2.4)}$$

where:

NEV = net economic value

PWTP = predicted willingness to pay (from interviews)

AD = total number of angler days

I estimated the total number of angler days by dividing total effort (in hours) by the average length of time anglers spent fishing (Equation 2.5).

$$AD = TE/AFT \qquad \text{(Equation 2.5)}$$

where:

AD = angler days

TE = total effort

AFT = average time spent fishing

I stratified by river section for the Smith River. The estimate for Philpott Reservoir was for the entire fishery.

I calculated total economic value by adding the travel expenses anglers incurred on their trip to the estimate of net economic value. Total travel expenses equaled average daily expenses multiplied by angler days.

Smith River

I generated a predictive model for six fishing scenarios (Figure 8, questions 19-24) in each of the three sections for a total of 18 models. I met with Virginia Department of Game and Inland Fisheries personnel to determine the fishing scenarios. I used different variables to begin modeling each scenario depending on which variables were removed during correlation analysis. The following are some of the variables I used: bait, lure, fly, # caught, miles traveled, gas, age, education, income, member of TU, reside instate.

Philpott Reservoir

I generated a willingness to pay model for each of the four fishing scenarios (Figure 9, questions 19-22) I presented to anglers during the on-site interview. I met with Virginia Department of Game and Inland Fisheries personnel to determine the fishing scenarios.

I analyzed willingness to pay data for Philpott Reservoir similarly to that of the Smith River, except that I treated the entire reservoir as one section. The following are some of the variables I used: bait, lure, fly, # caught, miles traveled, gas, age, education, income, member of fishing organization, reside instate. After I generated the willingness to pay models, I estimated net economic value using Equation 2.4.

RESULTS

Travel Cost Method

Smith River

In all three river sections, Henry county had the highest per capita visitation rate (Tables 44, 45, 46). Anglers from densely populated Roanoke County fished the most days in the middle section, despite their lower per capita visitation rate. Anglers traveled from as far away as Wake County, North Carolina, to fish the middle section of the river (an average of 256 miles one-way). Per capita visitation rate decreased with increasing distance in the upper and lower sections, but was less predictable in the middle section.

Predicting per capita visitation rate

I predicted per capita visitation rates at different mileage increments using the regression equations for each river section given below.

Upper (r^2 = 0.89):	PCV = 0.037 - 0.003(distance)	Equation 2.6
Middle (r^2 = 0.54):	PCV = 0.0028 - 0.00001122(distance)	Equation 2.7
Lower (r^2 = 0.61):	PCV = 0.0316 - 0.0002(distance)	Equation 2.8

I then combined predicted per capita visitation with census data to estimate total visits at a range of added costs (Tables 47, 48, 49).

Predicted total visits at zero additional miles were 5,019 angler-days in the upper section (Table 47), 1,979 in the middle section (Table 48) and 8,981 in the lower section (Table 49). Total estimated visits decreased to zero at 100 miles added distance in

Table 44. Estimated per capita visitation to the upper section of the Smith River.

County	Distance from river (round trip)	Annual angler days	County population	Per capita visitation rate
Henry	24.6	2,411	73,104	0.0330
Franklin	48.8	553	39,549	0.0140
Pittsylvania	99.8	553	108,711	0.0051
Roanoke	103.2	402	199,485	0.0020

Note: The regression of per capita visitation rate versus distance yielded an r^2 value of 0.89.

Table 45. Estimated per capita visitation to the middle section of the Smith River.

County	Distance from river (round trip)	Annual angler days	County population	Per capita visitation rate
Henry	30.6	209	73,104	.0030
Roanoke	99.2	278	199,485	.0014
Bedford	120	104	51,729	.0020
Guilford (NC)	125.6	209	600,335	.0004
Montgomery	135	139	73,319	.0019
Forsyth (NC)	150	139	409,363	.0003
Wake (NC)	256	278	631,331	.0004

Note: The regression of per capita visitation rate versus distance yielded an r^2 value of 0.54.

Table 46. Estimated per capita visitation to the lower section of the Smith River.

County	Distance from river (round trip)	Annual angler days	County population	Per capita visitation rate
Henry	11.42	3,226	73,104	.0441
Franklin	48.0	269	39,549	.0068
Pittsylvania	86.6	403	108,711	.0037
Roanoke	95.0	269	199,485	.0013
Guilford (NC)	147.6	538	600,335	.0009
Forsyth (NC)	150.0	269	409,363	.0007

Note: The regression of per capita visitation rate versus distance yielded an r^2 value of 0.61.

Table 47. Second stage demand use schedule for the upper section of the Smith River.

Added round trip distance	County				Total visits
	Henry	Franklin	Pittsylvania	Roanoke	
0	2,165	884	765	1,205	5,019
25	1,617	588	0	0	2,205
50	1,069	291	0	0	1,360
75	520	0	0	0	520
100	0	0	0	0	0

Table 48. Second stage demand use schedule for the middle section of the Smith River.

Added round trip distance	County							Total visits
	Henry	Roanoke	Bedford	Guilford (NC)	Montgomery	Forsyth (NC)	Wake (NC)	
0	180	337	75	835	95	457	0	1,979
25	159	281	61	667	74	342	0	1,584
50	139	225	46	498	54	228	0	1,189
75	118	169	32	330	33	113	0	794
100	98	113	17	161	12	0	0	401
150	57	1	0	0	0	0	0	58
200	16	0	0	0	0	0	0	16
300	0	0	0	0	0	0	0	0

Table 49. Second stage demand use schedule for the lower section of the Smith River.

Added round trip distance	County						Total visits
	Henry	Franklin	Pittsylvania	Roanoke	Guilford (NC)	Forsyth (NC)	
0	2,143	870	1,552	2,513	1,248	655	8,981
25	1,645	528	402	319	0	0	2,893
50	1,188	281	0	0	0	0	1,469
75	731	34	0	0	0	0	765
100	274	0	0	0	0	0	274
150	0	0	0	0	0	0	0

the upper section, slightly over 200 miles in the middle section and 150 miles in the lower section. Total cost of travel was $.54/mile in the upper section (Table 50), $.73/mile in the middle section (Table 51) and $.59/mile in the lower section (Table 52).

Estimate of consumer surplus

Consumer surplus was highest in the lower section at $109,148 (Figure 10) followed by the middle section at $62,743 (Figure 11), and lowest in the upper section at $50,965 (Figure 12). Anglers in the upper section spent the most money, on average, to fish the Smith River. Total angler expenditures in the upper section were $120,294 (Table 53). Anglers in the middle section spent an estimated $23,718 while anglers in the lower section spent $18,955. Total economic value was highest in the upper section of the river ($171,259), followed by the lower section ($128,103) and the middle section ($86,521; Table 53). However, on a per day basis, the middle section had the highest value ($46.27/day), which was more than twice as much as the lower section ($21.94/day), and more than three times the upper section (13.01/day; Table 53).

Philpott Reservoir

Anglers from Henry county fished more days and had the highest per capita visitation rate, while Campbell county, the county farthest from Philpott Reservoir (165 mile round trip on average), had the lowest number of angler days, and Roanoke County had the lowest per capita visitation rate (Table 54).

Table 50. Estimated cost of travel to the upper section of the Smith River.

Added miles	Added round trip miles	Time cost of travel[a]	Vehicle cost of travel[b]	Total cost of travel[c]	Total estimated visits
0	0	$0.00	$0.00	$0.00	5,019
12.5	25	2.52	4.25	6.77	2,205
25	50	5.03	8.50	13.53	1,360
37.5	75	7.55	12.75	20.30	520
50	100	10.07	17.00	27.07	0

[a]Time cost of travel = (round trip miles)(.25 average wage rate for upper section)/45 mph one quarter of the average hourly wage rate of anglers in the upper section = $4.53)
[b]Vehicle cost of travel = ($0.31/mile)/average party size = 0.17
[c]Total cost of travel in addition to actual expenditures = $0.54/mile.

Table 51. Estimated cost of travel to the middle section of the Smith River.

Added miles	Added round trip miles	Time cost of travel[a]	Vehicle cost of travel[b]	Total cost of travel[c]	Total estimated visits
0	0	$0.00	$0.00	$0.00	1,962
12.5	25	4.08	5.00	9.08	1,579
25	50	8.17	10.00	18.17	1,258
37.5	75	12.25	15.00	27.25	993
50	100	16.33	20.00	36.33	729
75	150	24.50	30.00	54.50	222
100	200	32.67	40.00	72.67	34
150	300	49.00	60.00	109.00	0

[a]Time cost of travel = (round trip miles)(.25 average wage rate for upper section)/45 mph one quarter of the average hourly wage rate of anglers in the middle section = $7.38)
[b]Vehicle cost of travel = ($0.31/mile)/average party size = 0.20
[c]Total cost of travel in addition to actual expenditures = $0.73/mile.

Table 52. Estimated cost of travel to the lower section of the Smith River.

Added miles	Added round trip miles	Time cost of travel[a]	Vehicle cost of travel[b]	Total cost of travel[c]	Total estimated visits
0	0	$0.00	$0.00	$0.00	8,981
12.5	25	3.07	4.25	7.32	2,893
25	50	6.13	8.50	14.63	1,469
37.5	75	9.20	12.75	21.95	765
50	100	12.27	17.00	29.27	274
75	150	18.40	25.50	43.90	0

[a]Time cost of travel = (round trip miles)(.25 average wage rate for upper section)/45 mph
one quarter of the average hourly wage rate of anglers in the lower section = $5.52)
[b]Vehicle cost of travel = ($0.31/mile)/average party size = 0.17
[c]Total cost of travel in addition to actual expenditures = $0.59/mile.

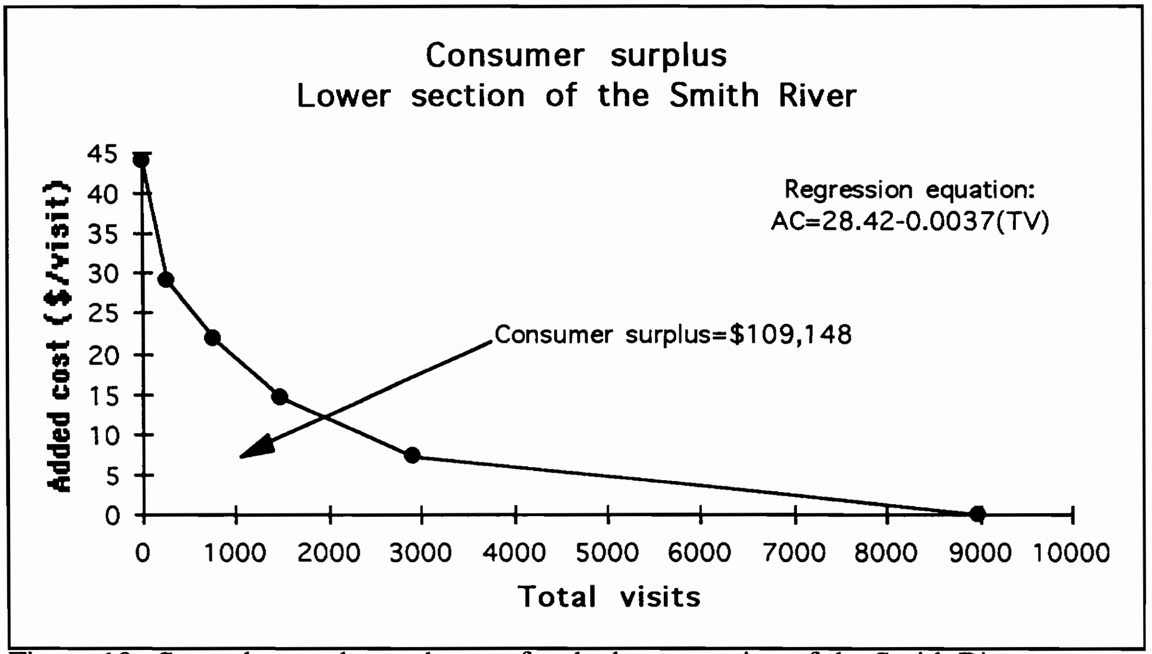


Figure 10. Second stage demand curve for the lower section of the Smith River. Consumer surplus is equal to the area under a regression line fit to the curve.

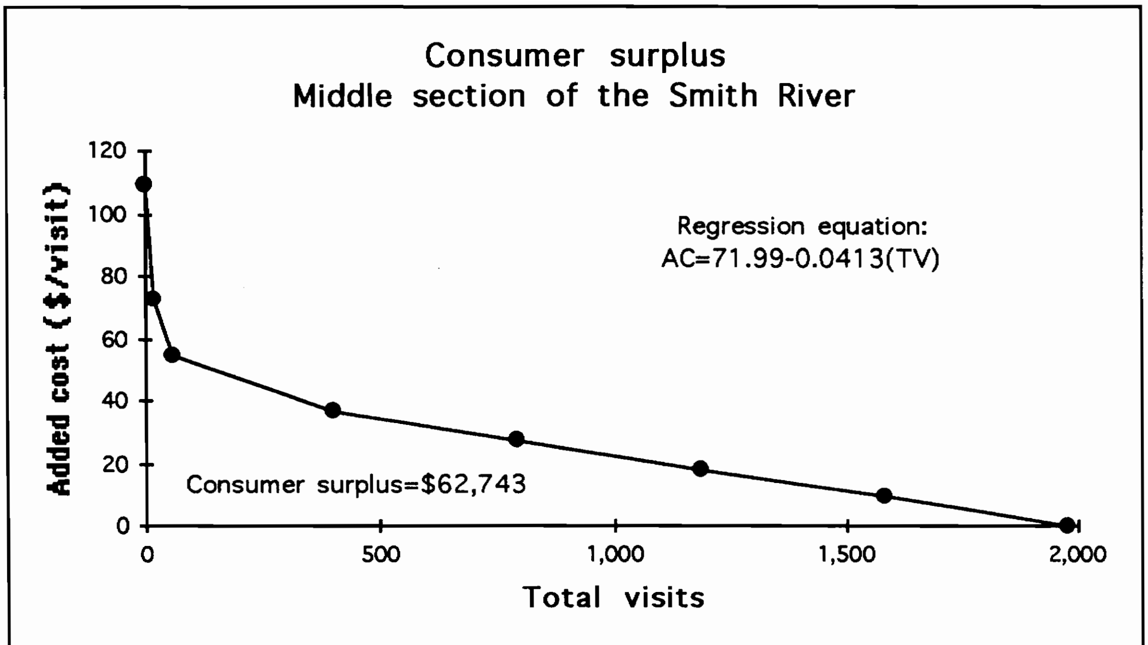


Figure 11. Second stage demand curve for the middle section of the Smith River. Consumer surplus is equal to the area under a regression line fit to the curve.

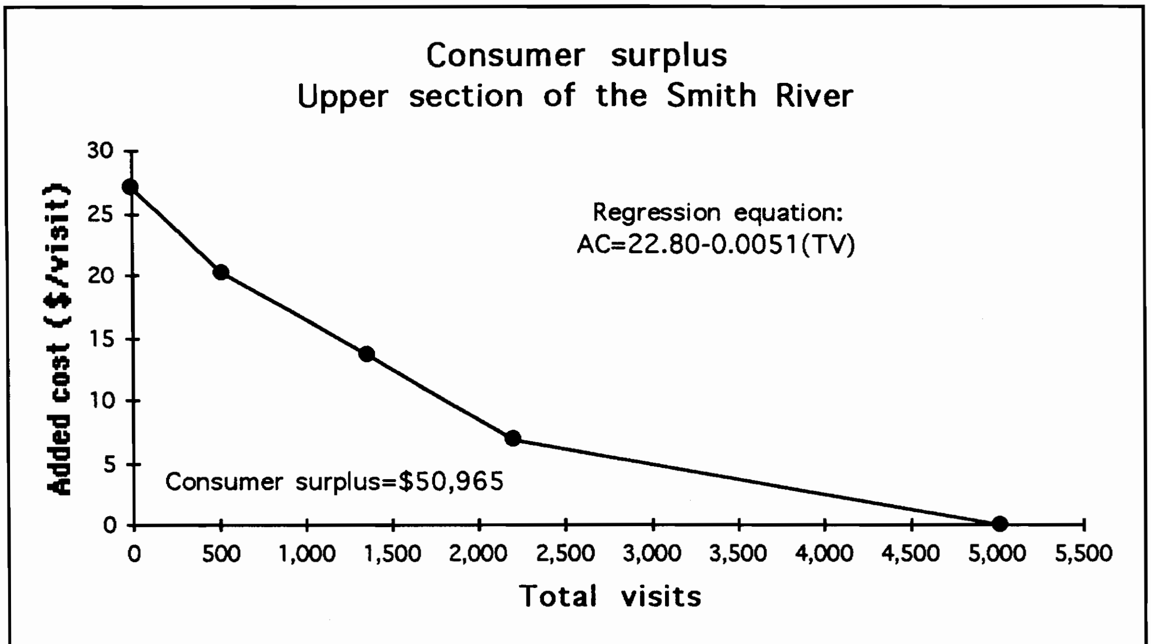


Figure 12. Second stage demand curve for the upper section of the Smith River. Consumer surplus is equal to the area under a regression line fit to the curve.

Table 53. TCM estimates of consumer surplus for each section of the Smith River.

River section	Consumer surplus	Consumer surplus/day	Angler expenditures	Total economic value
Upper	$50,965	$13.01	$120,294	$171,259
Middle	62,743	46.27	23,718	86,461
Lower	109,148	21.94	18,955	128,103
Grand total	222,856	____	162,967	385,823

Table 54. Estimated per capita visitation rate for Philpott Reservoir.

County	Round trip distance	Annual angler days	County population	Per capita visitation rate
Henry	22.84	4,857	72,754	0.067009
Franklin	29	214	39,549	0.005418
Patrick	49.64	910	17,473	0.052123
Floyd	60	214	12,005	0.01785
Pittsylvania	65	107	108,708	0.000986
Rockingham, NC	80	214	86,064	0.00249
Roanoke	82	268	199,485	0.001343
Surry, NC	105.5	214	61,704	0.003473
Stokes, NC	116.66	161	37,223	0.004318
Campbell	165	107	113,501	0.0000944

Predicting per capita visitation rate

Predicted per capita visitation to Philpott Reservoir (Equation 2.9) dropped to zero at 150 miles added distance (Table 55). The regression line did not fit the data well (r^2=0.34).

PCV = 0.0406 - 0.0003(distance) Equation 2.9

where:

PCV = Per capita visitation rate

Total estimated visits decreased from 12,113 at zero additional miles to 448 at 100 additional miles, and then to zero at 150 additional miles (Table 56). Total cost of travel was $.57/mile (Table 57). Table 57 shows the time cost of travel, vehicle cost of travel, total travel cost, and total estimated visits at each round trip mileage increase. Total cost increased as I added mileage to an angler's travel distance. An increase of $42.63 per trip is the added cost of travel at an additional travel distance of 150 miles, at which cost total estimated visits are zero.

Estimate of consumer surplus

Integration of the demand function (Equation 2.10) yielded an estimated consumer surplus of $163,630 (Figure 13).

Regression equation: added cost = 30.54 - 0.00285(TV) (r^2=0.80) Equation 2.10

Table 55. Predicted per capita visitation rate for Philpott Reservoir.

	Added round trip distance (miles)					
County	0	25	50	75	100	150
Henry	0.0337	0.0262	0.0187	0.0112	0.0037	----
Franklin	0.0319	0.0244	0.0169	0.0094	0.0019	----
Patrick	0.0257	0.0182	0.0107	0.0032	----	----
Floyd	0.0226	0.0151	0.0076	0.0001	----	----
Pittsylvania	0.0211	0.0136	0.0061	----	----	----
Rockingham, NC	0.0166	0.0091	0.0016	----	----	----
Roanoke	0.0160	0.0085	0.0010	----	----	----
Surry, NC	0.0090	0.0015	----	----	----	----
Stokes, NC	0.0056	----	----	----	----	----
Campbell	----	----	----	----	----	----

Table 56. Predicted visits by county for Philpott Reservoir (predicted per capita visitation rate times county population).

	Added round trip distance (miles)					
County	0	25	50	75	100	150
Henry	2,455	1910	1364	818	273	0
Franklin	1,262	965	668	371	75	0
Patrick	449	318	187	56	0	0
Floyd	271	181	91	1	0	0
Pittsylvania	2294	1478	663	0	0	0
Rockingham, NC	1429	783	138	0	0	0
Roanoke	3192	1696	199	0	0	0
Surry, NC	552	89	0	0	0	0
Stokes, NC	209	0	0	0	0	0
Campbell	0	0	0	0	0	0
Total visits	12,113	7,445	3,360	1,321	448	0

Table 57. Estimated cost of travel at each mileage increment for Philpott Reservoir.

Added miles	Added round trip miles	Time cost of travel	Vehicle cost of travel	Total cost of travel[a]	Total estimated visits (angler days)
0	0	$0.00	$0.00	$0.00	12,113
12.5	25	2.86	4.25	7.11	7,445
25	50	5.71	8.5	14.21	3,360
37.5	75	8.57	12.75	21.32	1,321
50	100	11.42	17.00	28.42	448
75	150	17.13	25.50	42.63	0

[a]Total cost of travel in addition to actual expenditures = $0.57/mile.

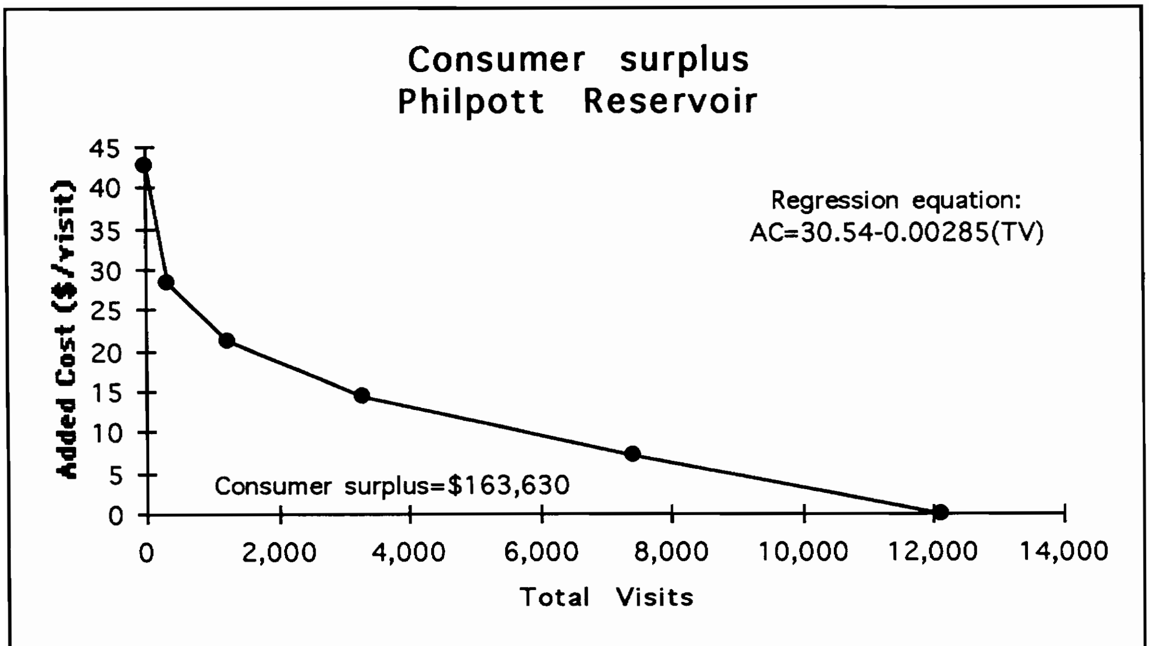


Figure 13. Second stage demand curve for Philpott Reservoir. Consumer surplus is equal to the area under a regression line fit to the curve.

Anglers spent an average of $23.85 per trip, for a total of $173,747, which when added to consumer surplus yields a total economic value of the Philpott Reservoir fishery of $337,377.

Contingent Valuation Method

Smith River

Predictive models

How well a model predicted an angler's willingness to pay is determined by an adjusted r^2 value, which is similar to r^2 in that it represents the percentage of the variation in the dependent variable that is explained by the independent variable. An adjusted r^2 takes into account that there is more than one variable on the right hand side of the model equation. Adjusted r^2 penalizes for having more right hand side variables, which by theory, increases the amount of explained variation. My goal was to find the model with the fewest variables that explained the most variation. Some of the adjusted r^2 values are low because I was not analyzing time series data, which generally produce better fitting models (Studenmund and Cassidy 1987). Cross-sectional data typically produce r^2's in the 0.10-0.30 range.

Generating a model for each river section and fishing scenario allowed me to characterize anglers in a general way with respect to what may influence how much more they would be willing to pay for a given fishing scenario. Travel-related variables (miles, gas, hours spent traveling) were statistically significant in nearly all of the models, and were especially important to anglers in the middle section (Tables 58, 59, 60). At least one travel-related variable (miles traveled) was a statistically significant predictor of willingness

Table 58. Willingness to pay models for the upper section of the Smith River.

Willingness to pay question	Sample size	Significant variables	Coefficient	p-value	Adjusted r^2
Current conditions[a]	----	----	----	----	----
Catch a limit[a]	----	----	----	----	----
Catch a wild trout	78	lure	-33.3	0.09664	0.28
		miles	2.8	0.00000	
		time	-3.3	0.00000	
		gas	4.5	0.00467	
Catch a trout > 16 in.[a]	----	----	----	----	----
More predictable flows	78	hours	-.4	0.10816	0.05
		age	-0.8	0.04666	
		income	0.00004	0.03803	
Not have to stop fishing due to flows	78	hours	-4.6	0.07823	.09
		age	-0.9	0.04789	
		lneducation[b]	-60.8	0.09547	
		income	0.00007	0.00468	

[a]the model produced negative adjusted r^2 values
[b]natural log of mean highest education level completed

Table 59. Willingness to pay models for the middle section of the Smith River.

Willingness to pay question	Sample size	Significant variables	Coefficient	p-value	Adjusted r^2
Current conditions	47	hours	5.3	0.03225	0.40
		lnmiles	-11.1	0.05497	
		gas	4.6	0.00000	
Catch a limit	54	time	-0.4	0.00715	0.34
		miles	0.5	0.00098	
Catch a wild trout	54	lnmiles	-46.2	0.00000	0.50
		time	0.9	0.00000	
Catch a trout	47	fly	31.1	0.02166	
> 16 in.		lnmiles	-37.3	0.00000	0.63
		age	-0.7	0.07424	
		time	0.6	0.00000	
		gas	1.8	0.08057	
More predictable flows	48	hours	-8.4	0.03249	0.26
		satisfactio	-27.3	0.03604	
		n	0.3	0.00373	
		miles	-1.5	0.02978	
		age			
Not have to stop fishing due to flows	16	hours	-21.5	0.00982	0.66
		times	-8.2	0.10526	
		miles	1.2	0.00000	
		TU	-51.1	0.04036	
		education	16.0	0.03706	

Table 60. Willingness to pay models for the lower section of the Smith River.

Willingness to pay question	Sample size	Significant variables	Coefficient	p-value	Adjusted r^2
Current conditions	28	lure	21.3	0.01035	0.28
		fly	-30.9	0.00423	
		# caught	-3.9	0.03866	
		miles	-2.4	0.00774	
		satisfaction	-14.6	0.04493	
		education	3.6	0.02316	
		time	2.5	0.00162	
		times fished	0.30	0.04137	
Catch a limit	24	lure	-36.4	0.03838	0.05
		fly	-50.7	0.03240	
		# caught	-8.9	0.01227	
		miles	-6.8	0.00234	
		lnincome	17.2	0.09312	
		age	-1.5	0.00023	
		time	5.7	0.00177	
		any organization	-36.9	0.00915	
Catch a wild trout	35	fly	-49.4	0.01250	0.15
		lnmiles	10.6	0.06646	
		education	4.8	0.08509	
Catch a trout > 16 in.	24	satisfaction	-49.0	0.00074	0.62
		lneducation	62.9	0.10178	
		income	-0.0008	0.03785	
		gas	14.6	0.00000	
		caught	-10.8	0.01128	
More predictable flows	35	lure	31.2	0.06661	0.27
		fly	-61.3	0.00584	
		satisfaction	-25.6	0.06899	
		miles	0.8	0.00548	
		education	8.3	0.03218	
Not have to stop fishing due to flows	39	hours	-24.7	0.07304	0.01
		miles	1.2	0.07753	

to pay in each of the six models in the middle section (Table 59). Socioeconomic variables, such as education, age, and income were also statistically significant in some models, however, they were not as common as travel-related variables. Overall, adjusted r^2 values were good, ranging from a high of 0.66 (Table 59) to a low of 0.01 (Table 60).

Net economic value

I estimated net economic value for each fishing scenario in each river section (Tables 61, 62, and 63). In the upper section, anglers were willing to pay the most for an increased chance to catch a large trout, which was twice the value of the fishery under current conditions (Table 61). Catching a wild trout, which was nearly twice that of current conditions, and catching a limit of trout also had high mean willingness to pay values in the upper section, while more predictable flows had the lowest value ($8.18). The high mean willingness to pay values for an increased chance of catching a large trout and a wild trout translated into high net economic values for these fishing scenarios. I estimated consumer surplus to be $103,145 for an increased chance of catching a large trout, 16% higher than the value of catching a wild trout ($87, 084). The only two fishing scenarios that had lower average willingness to pay values than that of current fishing conditions ($12.79) were a fishing scenario with more predictable flows ($8.18), or if anglers did not have to stop fishing due to high flows ($10.08; Table 61). These two fishing scenarios also had lower net economic values than that of the fishery under current conditions.

Anglers fishing the middle section of the Smith River were willing to pay, on average, $14.13 more than their travel expenses for the current fishing conditions on the Smith River. The only fishing scenario with a lower average willingness to pay value was that for a more predictable flow regime ($9.91; Table 62). This fishing scenario also had

Table 61. Consumer surplus, estimated using the CVM, for each fishing scenario in the upper section of the Smith River.

Fishing scenario	Mean response (dollars)	Consumer surplus[a]	Total economic value
Current conditions	$12.79	$50,103	$170,397
Limit of trout	19.24	75,371	195,665
Wild trout	22.23	87,084	207,378
Large trout	26.33	103,145	223,439
Predictable flows	8.18	32,044	152,338
Not have to stop fishing due to flows	10.08	39,487	159,781

[a]Consumer surplus was calculated by multiplying the mean willingness to pay value by the number of angler days (3,917.39). Total economic value includes expenditures for a fishing trip ($120,294 in upper section).

Table 62. Consumer surplus, estimated using the CVM, for each fishing scenario in the middle section of the Smith River.

Fishing scenario	Mean response (dollars)	Consumer surplus[a]	Total economic value
Current conditions	$14.13	$19,171	$42,889
Limit of trout	14.30	19,401	43,119
Wild trout	21.87	29,673	53,391
Large trout	29.54	40,079	63,797
Predictable flows	9.91	13,446	37,164
Not have to stop fishing due to flows	21.07	28,587	49,305

[a]Consumer surplus was calculated by multiplying the mean willingness to pay value by the number of angler days (1,356.77). Total economic value includes expenditures for a fishing trip ($23,718 in middle section).

Table 63. Consumer surplus, estimated using the CVM, for each fishing scenario in the lower section of the Smith River.

Fishing scenario	Mean response (dollars)	Consumer surplus[a]	Total economic value
Current conditions	$9.12	$45,363	$64,318
Limit of trout	11.77	58,544	77,499
Wild trout	15.59	77,545	96,500
Large trout	33.21	165,187	184,142
Predictable flows	7.13	35,465	54,420
Not have to stop fishing due to flows	21.97	109,279	128,234

[a]Consumer surplus was calculated by multiplying the mean willingness to pay value by the number of angler days (4974.01). Total economic value includes expenditures for a fishing trip ($18,955 in lower section).

the lowest net economic value. Anglers were willing to pay the most for an increased chance of catching a large trout ($29.54; consumer surplus = $40,079), which was more than twice the value of the fishery under current conditions. The wild trout scenario ($21.87; consumer surplus = $29,673) and the high flow scenario were both approximately 33% higher than the value of the fishery under current conditions. Middle section anglers valued catching large trout more than twice as much as catching a limit of trout. Anglers were willing to pay an additional $21.07 for the assurance of not having to stop fishing due to high flows (Table 62). More predictable flows were valued the least of any fishing scenario ($9.91; $13,446).

A more predictable flow regime was valued lowest ($7.13) by anglers fishing the lower section of the Smith River, even lower than the value of the fishery under current conditions ($9.12; Table 63). An increased chance to catch a large trout had, by far, the highest average willingness to pay and net economic values ($33.21; consumer surplus = $165,187), a 73% increase from the current conditions scenario. Anglers in the lower section also highly valued the scenario of not having to stop fishing because of high flows ($21.97; consumer surplus = 109,279; Table 63). Lower section anglers valued catching a large trout more than twice much as catching wild trout and a limit of trout.

Differences between river sections: An increased chance of catching a large trout was valued the highest of any fishing scenario, while anglers in all three river sections valued a more predictable flow regime the lowest of any of the fishing scenarios (Table 64). The fishery under current conditions was valued highest by anglers in the middle section, followed by the lower and upper sections, respectively. An increased chance of catching a wild trout was valued second highest in the upper and middle sections, and third highest in the lower section (Table 64). Anglers in the upper section placed a low value on

Table 64. Mean willingness to pay values, in dollars, for each fishing scenario in each river section.

River section	Fishing scenario					
	Current conditions	Catch a limit	Catch a wild trout	Catch a trout >16 in.	More predictable flows	Stop fishing due to high flows
Upper	$12.79	$19.24	$22.23	$26.33	$8.18	$10.08
Middle	14.13	14.30	21.87	29.54	9.91	21.07
Lower	9.12	11.77	15.59	33.21	7.13	21.97

not having to stop fishing due to high flows ($10.08). Anglers in the middle and lower sections valued not having to stop fishing more highly than anglers in the upper section (Table 64). The increased opportunity of catching a limit of trout was valued highest by anglers fishing in the upper section of the Smith River ($19.24), compared to the middle ($14.30) and lower sections ($11.77; Table 64).

Philpott Reservoir

Predictive models

I generated predictive models for each fishing scenario for Philpott Reservoir except current conditions (Table 65). Each of the three models generated contained at least one travel-related variable (gas, instate, hours). The "instate" variable represented anglers who lived in the state of Virginia. The variable "anyclub" (which represents whether an angler belonged to a fishing club or other type of conservation organization) was statistically significant in the walleye and trout fishing scenarios. Number of fish caught was a statistically significant predictor of an angler's willingness to pay for both the black bass ($p=0.09919$) and trout ($p=0.07811$) fishing scenarios. The model for an increased chance of catching a walleye had the highest adjusted r^2 value ($r^2=0.15$) of the three models, followed by the trout ($r^2=0.14$) and black bass ($r^2=0.09$) models.

Net economic value

The black bass fishing scenario had the highest mean willingness to pay value ($9.68) and highest consumer surplus ($70,529) of the four options (Table 66). Each of the mean willingness to pay values and estimates of consumer surplus, except for

Table 65. Willingness to pay models for Philpott Reservoir.

Willingness to pay question	Sample size	Significant variables	Coefficient	p-value	Adjusted r^2
Current conditions[a]	----	----	----	----	----
Black Bass	141	Gas	0.23	0.00905	0.09
		Times	0.06	0.09082	
		# Caught	-0.2	0.09919	
		Education	0.7	0.18098	
Walleye	143	Miles	1.5	0.08685	0.15
		Anyclub	-5.6	0.10574	
		Instate	-16.0	0.00768	
Trout	141	Hours	-0.8	0.17695	0.14
		Times	-0.1	0.10735	
		# Caught	0.2	0.07811	
		Education	1.2	0.09306	
		Anyclub	-4.0	0.20119	
		Instate	-11.8	0.00470	

[a]the model generated for current conditions produced negative adjusted r^2 values

Table 66. Mean willingness to pay and net economic values for Philpott Reservoir.

WTP Question	Mean WTP	Net economic value
Current conditions[a]	$5.74	$41,822
Black bass	9.68	70,529
Walleye	6.75	49,181
Trout	4.71	34,536

Note: angler days = 7,286

the trout scenario, were higher than the estimate of the fishery under current conditions. Mean willingness to pay for the walleye fishing scenario was about $1.00 higher ($6.75) than that for the current conditions (5.74) and, consequently, the estimate of consumer surplus was also higher at $49,181 compared to $41,822 (Table 66).

DISCUSSION

Smith River

Using both the TCM and CVM to estimate net economic value was beneficial because the TCM is based estimates on actual angler behavior, while the CVM allowed me to estimate economic value under different fishing scenarios. The TCM allowed me to estimate consumer surplus based on how far anglers traveled to the Smith River and Philpott Reservoir, and how much they spent getting there. The CVM allowed me to assess relative values of several alternative management scenarios. Consumer surplus was highest in the middle section when standardized on a per day basis. Total value was lower than the other two sections because of the middle section's short length and low total angler effort. Angler effort is a key component of the consumer surplus estimate.

Over one-half of the anglers I interviewed in the middle section lived out-of-state, primarily in North Carolina. A high number of anglers resided in the Research Triangle area of North Carolina (Raleigh, Durham, Chapel Hill), leading to the high per-angler-day estimate of consumer surplus. Although the middle section is the shortest, the uniqueness of the section appeals to many anglers. Effort in the middle section was lowest of any section and occurred almost exclusively on weekend days, due to the current flow regime. Consumer surplus of the entire river could be increased significantly if effort increased from expansion of the middle section. The middle section attracts anglers who spend considerable amounts of money traveling to the Smith River, and who have high consumer surplus. Wading is the exclusive mode of fishing in the middle section. A flow regime designed to allow for wading at all times, not only during periods of nongeneration on weekends, could also increase overall consumer surplus and further offset revenues lost by a change in how the dam is operated.

The upper section had the highest total economic value, however this figure was somewhat inflated due to one group of anglers who traveled a considerable distance for a multiple-day trip. Travel expenses for these anglers included lodging and higher than usual costs for gas.

Contingent Valuation Method

In the upper section, three of the four significant variables were travel-related in the model for catching a wild trout. The lack of other wild trout fisheries in the region draws anglers from considerable travel distances, further emphasizing travel-related variables.

In the middle section, the travel variable "miles" or its natural log was significant in each of the six models. Anglers traveled farther to fish the middle section than the other two sections. Similarly, time spent traveling and amount of money spent on gas were significant. The significance of the travel related variables in the models in the middle section further shows the importance of travel on an angler's willingness to pay. Since most of the anglers who fish the middle section travel considerable distances, they must make a significant investment in the form of time and money to fish the river.

Surprisingly, flow-related variables did not contribute to models in the middle section. Since anglers in the middle section travel significant distances, I expected flow related variables to be important, and to be statistically significant predictors of willingness to pay. The only significant flow related variable was "satisfaction", which measured an angler's satisfaction with current flow regime.

Travel related variables also were statistically significant in most of the predictive models for the lower section of the river, specifically "miles" (miles traveled to the Smith River) and "time" (time spent traveling). I did not expect travel related variables to be significant predictors of willingness to pay in the lower section, since anglers in this section, on average, traveled the shortest distance to the river. Fishing related variables, such as "number of fish caught" and "fly" (fly fishing) also were significant in some of the models. I did not expect "fly" to be significant in the lower section since most anglers did not use this technique when fishing. A flow regime designed to enhance the overall fishery, such as producing more, larger trout, would also increase consumer surplus of the river. A better fishery may attract more anglers, some from far away.

Mean willingness to pay values

I expected anglers in the upper and lower sections to differ from anglers in the middle section with respect to what they valued in a fishing trip. For example, I expected anglers in the upper and lower sections to place a high value on catching a limit of trout, and flow related scenarios to be valued less. Surprisingly, anglers in all three river sections valued catching a large trout highest of any of the fishing scenarios. The flow related scenarios, specifically "more predictable flows" had low willingness to pay values compared to other scenarios. This suggests that the flow issue is not particularly important to anglers, perhaps because anglers are accustomed to the current flow regime, and know what flow conditions to expect on days they fish. Seventy-five percent of the anglers in the upper and lower sections knew the flow conditions for the day prior to fishing, and 85% of the anglers I interviewed in the middle section knew the flow conditions for the day. Anglers may be apprehensive to place value on a proposed changed in the flow regime because a possible change may result in worse flow conditions, or they had simply adapted their behavior to the current flow regime.

The most unexpected result was the low value anglers in the middle section placed on more predictable flow scenarios. Since anglers in this section traveled considerable distances to fish the river, I expected them to be very interested in improving the flow regime or making the flow regime more predictable. However, the flow regime is currently predictable because the USCOE posts the week's generating schedule on a phone recording. Anglers did value the scenario of not having to stop fishing due to high flows (almost as high as they did wild trout). This suggests that eliminating the issue of high flows altogether, and making the river fishable at all times during the week, is more appealing to anglers in the middle section. Most of the anglers in the middle section fish while wading, an impossibility during high flows.

Anglers in the lower section also placed a fairly high value on catching wild trout. I expected anglers in this section to be more interested in catching a limit of fish, rather than catching wild trout. However, it was apparent that anglers in all three river sections valued the opportunity to catch a wild trout highly.

Consumer surplus differences

If consumer surplus for a given fishing scenario is higher than that under current conditions, it suggests consumer surplus could be increased if the hypothetical fishing scenario could be implemented. All of the fishing scenarios had higher values of consumer surplus compared to current conditions, except for "more predictable flows" and "not having to stop fishing due to high flows" in the upper section, and "more predictable flows" in the middle section. This suggests that anglers are not willing to pay more for a more predictable flow regime, when the current flow regime is already predictable.

However, anglers in the middle and lower sections were willing to pay more if they didn't have to stop fishing due to high flows. Anglers in the upper section differed in that they did not value either flow scenario higher than the fishery under current conditions. There are a few areas where anglers can fish safely directly below the dam during high flows. This may be a reason for the lack of interest in flow issues by anglers in the upper section. However, I did not see many anglers fishing directly below the dam during times of high flows. In all the other fishing scenarios, consumer surplus was higher than that under current conditions, which suggests anglers are willing to pay more for a better fishing trip. This is especially true of the increased chance of catching more trout, larger trout, and wild trout.

Comparison of the TCM and CVM

Travel cost method estimates of consumer surplus for the fishery under current conditions exceed those of the CVM in all three river sections. In both the middle and lower sections, the TCM estimate of consumer surplus was more than twice the CVM estimate. In the upper section, the two estimates were very close at a difference of only $862.

Since the TCM is based on actual angler behavior, factoring travel distance and travel costs into the estimate, the TCM may be a more reliable estimate. However, I intentionally made it conservative by using 0.25 of the wage rate. The CVM-produced estimates for the different fishing scenarios are useful to compare to the value of the fishery under current conditions. In each of the three river sections, consumer surplus for catching a large trout was more than twice as much as consumer surplus for the fishery under current conditions, which suggests consumer surplus potentially could be doubled if an improved flow regime produced more, larger trout. Consumer surplus for the large trout scenario increased by 73% in the lower section and approximately 50% in the upper and middle sections (assuming no change in effort). Consumer surplus for the wild trout scenario increased by approximately 42% in the upper and lower sections, and 35% in the middle section. Producing more wild trout is another area managers could focus on in efforts to increase overall consumer surplus of the fishery. I included only five aspects of the fishery that may be managed to improve the fishery and possibly increase consumer surplus. There may be other components to the fishery that anglers value. For example, anglers may be willing to pay for increased access, which would contribute to my estimate of consumer surplus.

The usefulness of the CVM was fully recognized when I estimated the value of the fishery under different fishing conditions. I wanted to determine how much consumer surplus could be increased, and under what type of conditions that would be possible. The TCM cannot be used for this type of analysis. One of the criticisms of the CVM is that if anglers are asked hypothetical questions, they will respond with a hypothetical answer. Using the payment card method, I attempted to eliminate haphazard responses to my contingent valuation questions. However it was difficult at times to explain to anglers I was interviewing what they were supposed to do with respect to picking a dollar value from a card after I asked them a CV question. The payment vehicle I chose was an increase in travel expenses. In other words I asked anglers how much they would be willing to pay for a given fishing scenario, above what they had already spent on travel expenses. I believe some of the anglers I interviewed actually thought they would realize an increase in their travel expenses if they chose a high dollar value.

Value of the Fishery and Value of Power Produced at Philpott Dam

A primary objective of the economic component of this project was to compare the value of the trout fishery under the current flow regime to the value of power produced at Philpott Dam, or more importantly to make comparisons between the potential increase in consumer surplus of the fishery to potential losses in revenue if the dam was operated differently. Currently, Philpott Dam is operated in a peaking mode, generating power in response to demand for power. Peaking is the most profitable mode of operation. Although the value of the fishery could be increased, it would have to be done at the cost of decreased power revenue due to changes from the current peaking mode. The important question is will lost revenue be offset by increased net economic value of the fishery?

The Southeastern Power Administration (SEPA) is responsible for establishing contracts with power companies and municipalities to market power from Philpott Dam and other Federal projects. The value of power produced at Philpott Dam during fiscal year 1995 was $669,375 (Herb Nadler, SEPA, pers. comm.) under a peaking mode regime designed to maximize revenues from power production. The CVM estimate of consumer surplus for the current fishing conditions was $277,604. The overall value of the fishery increased by nearly $200,000 to $471,378 for the fishing scenario of catching larger trout. However, consumer surplus does not factor in what anglers have already spent on fishing trip. The total economic value of the fishery under current fishing conditions was $440,571, a difference of $228,805. The fishing scenario that had the highest total value (large trout: $634,345) was only $35,050 less than the $669,375 in revenues from power production under a peaking mode of operation. Consumer surplus increased from current conditions value in four of the five scenarios. If the current flow regime were changed from the current peaking mode, to one that provided higher minimum flows and less peaking, revenue loss may result. However, an enhanced fishery, one that produces more, larger trout, may offset potential losses in revenue through an increase in total economic value of the Smith River fishery. I have demonstrated the value of the fishery under the large trout scenario which is based on current angler effort estimates. A change in the flow regime which eliminates peaking flows, and is designed to improve production of large trout and wild trout, would increase angler effort because of improved fishing opportunities, up until a point of congestion. As a result, consumer surplus would probably increase and offset losses accrued from a changed flow regime.

Consumer surplus is based on how many anglers fish the river, travel distance, and travel costs (TCM), so it may be increased if the fishery were enhanced to attract more anglers. However, attracting more anglers creates a different set of problems, such as overcrowded fishing areas, a distinct possibility in the middle section. Anglers seem to have adapted to the current situation, and may not welcome a change that could possibly attract more anglers.

I have shown the importance of the middle section to the economic value of the fishery, which had the highest per day net economic value of any section. Targeting this section may be a way to increase net economic value of the fishery. For example, the middle section could be expanded in an attempt to attract more anglers to the unique fishery. Under a flow regime that reduced peaking, provided higher base flows, and promoted production of large, wild trout, anglers in the middle section may be able to fish during the week, rather than almost exclusively on weekend days. I estimated effort on week days in the middle section for the entire study period at only 762 angler-hours. Angler-effort on weekend days was more than 7 times higher. Conversely, angler-effort on weekdays in the upper section was higher than on weekend days, while effort in the lower section was slightly higher on weekend days than weekdays. If the dam were operated with less peaking, making the section available to fish during the week, more anglers may fish during the week, therefore increasing total angler-effort and total economic value. Weekday effort may never equal weekend day effort in the middle section, even with less peaking, due to the considerable distances most anglers drive to fish the Smith River. However if weekday effort were increased to half that of weekend day effort (increase of nearly 2,000 angler-hours, and 430 angler days), consumer surplus would increase under current fishing conditions by 32%. Changing the flow regime to eliminate peaking flows would benefit the fishery in many ways, such as improved habitat and more, deeper water. An improved fishery and increased fishing opportunities for anglers would attract more anglers and increase overall economic value of the fishery. Because of these many benefits, it would be cost effective to change the current operation of Philpott Dam.

Using two methods to estimate consumer surplus provides Virginia Department of Game and Inland Fisheries (VDGIF) managers with two estimates of consumer surplus under current fishing conditions, and relative estimates of consumer surplus under five different fishing scenarios. VDGIF managers can consider how anglers valued each of the fishing scenarios when making future management decisions. A possible future management decision is expansion of the middle section, an interest of many of the anglers I interviewed in the upper and middle sections. Increasing this section may increase consumer surplus, but local anglers in the upper and lower sections may be replaced by more out-of-state anglers. The consumer surplus generated by those local anglers would also be lost. Managers need to assess the tradeoffs associated with making such a management decision, and can use the information I have presented in this chapter to make such an assessment.

Philpott Reservoir

The TCM estimate of consumer surplus for Philpott Reservoir exceeded the CVM estimate by more than a factor of two. The CVM was useful for estimating the value of the fishery under different fishing scenarios, such as increasing an angler's chances of catching a black bass, walleye or trout.

Each of the predictive models I generated for each fishing scenario contained different significant variables that predicted an angler's willingness to pay. The three fishing scenarios for which I generated predictive models contained a travel-related variable. Anglers on average did not travel a great distance to fish Philpott Reservoir, but nonetheless travel expenses were still important. The number of fish caught was a significant predictor of willingness to pay for the black bass fishing scenario. During angler interviews, many anglers responded to my introductory question of how their day went by telling me how many fish they had caught, and then their size. Numbers of fish caught concerned bass anglers more than any other group. It was difficult to determine the importance of significant variables in each of the models for the trout and walleye scenarios because I did not interview any anglers during the study period who were fishing for these species. Similar to the Smith River, income, in some form, was noticeably absent from all of the Philpott Reservoir models.

Mean Willingness to Pay Values

Not surprisingly, anglers were willing to pay the most for an increased chance of catching a black bass. Seventy five percent of the anglers I interviewed were targeting black bass, and 67% of angler effort was directed toward black bass. Anglers were willing to pay the least for an increased chance of catching trout. Neither trout nor walleye were targeted by any of the anglers I interviewed. The trout fishery was quite popular among local anglers until the USCOE disallowed fishing in the immediate vicinity of the dam. Many anglers caught trout in deep water next to the dam. I did interview some anglers who fish for trout, but were not targeting trout the day I interviewed them. These anglers said an effective technique to catch trout is using downriggers trolling at deeper depths. Another aspect limiting the trout fishery is availability of the fish. Even though trout have been stocked by VDGIF, they are rarely caught in regular gill net sampling.

Walleye are caught more often in gill net sampling. However, anglers have not embraced walleye fishing in Philpott Reservoir with enthusiasm. This may be a result of the nature of the walleye, and its historic distribution. Walleye are typically found in the cooler waters of Northern states. Anglers who fish Philpott Reservoir may not be familiar with walleye and the techniques needed to effectively fish them. The few anglers I interviewed who caught walleye, caught them accidentally while fishing for bass in the upper Smith River.

The TCM estimate of the Smith River fishery ($222,856) was higher than the value of the Philpott Reservoir TCM estimate of $163,630. The CVM estimate for the Smith River ($114,637) was also higher than the reservoir estimate of $41,822. However the Smith River received roughly twice the pressure of Philpott Reservoir.

CHAPTER 3

Characteristics, Specialization and Attitudes of Smith River and Philpott Reservoir Anglers

INTRODUCTION

In this chapter I will address objectives #2 and #5, describing demographic, socioeconomic, and gear preference characteristics, and attitudes toward future management of the Smith River and Philpott Reservoir. I will describe characteristics such as mode of fishing (fly, bait, lure) and socioeconomic (income level, educational level).

Other researchers also have used creel surveys to collect data for the purposes of characterizing anglers. Gigliotti and Peyton (1993) used a creel survey to determine attitude differences between members and nonmembers of fishing organizations toward implementation of a proposed catch-and-release regulation for a Michigan trout fishery. Chipman and Helfrich (1988) grouped anglers by degree of fishing specialization and motivation for angling.

There are many ways to characterize specialization in anglers. For example, an angler targeting a specific species demonstrates a form of specialization. Anglers who target specific species often specialize further, such as the type of gear they prefer, of the type of setting in which they like to fish (Bryan 1977). Different fish species often dictate that anglers become specialized in order to have a successful fishing trip. For example, anglers who specialize in catching largemouth bass often specialize further in their techniques for catching fish (e.g., bait versus lure), the type of water body they fish best on (e.g., river, lake, pond), or whether they fish from shore or from a boat.

It is important for managers to know how users of a resource specialize to get the most out of their fishing experience. I will explore specialization and how it relates to angler characteristics and management preferences of anglers who fish the Smith River and Philpott Reservoir.

METHODS

Using the forms shown in Figures 8, and 9 I conducted on-site interviews as previously described to collect all the information needed to characterize anglers who fish the Smith River and Philpott Reservoir.

Smith River

I characterized anglers in each of the three river sections. In addition to general characteristics, I also asked anglers a question related to management of the river to determine which areas they would like to see emphasized in the future (Figure 8, question 27).

27.) Please assign a number value to each of the following areas that VDGIF management efforts should be directed. 1=low effort, 5=high

a.) stocking	1	2	3	4	5
b.) flow management	1	2	3	4	5
c.) fishing regulations	1	2	3	4	5
d.) increased access (parking, trails, etc.)	1	2	3	4	5
e.) other ______________________	1	2	3	4	5

- Which of the above management options is most important to you? (circle the letter of the most important) None_______

I asked anglers to assign a value of 1-5 to each management option, a higher number corresponding to increased future effort in that area. I averaged all the responses for each management option then ranked them from highest to lowest to determine which were most important.

I also characterized anglers by factors that influenced them to fish the Smith River. During the interview, I gave anglers a notecard with a series of factors that may have influenced them to fish the Smith River and asked them to designate their top three reasons for fishing the river (Figure 8, question 25).

25.) Which factors were most important in your choosing to fish the Smith River today?

a.) opp. to catch lots of fish ____	e.) to test my fishing skills ____	i.) to view the scenery ______
b.) opp. to catch wild trout ____	f.) I've had success here before ____	j.) for the solitude ______
c.) opp. to catch stocked fish ____	g.) where my friends were going____	k.) close to home ______
d.) opp. to catch a trophy fish____	h.) to be with friends or family ____	l.) to catch fish to eat ______
		m.) other________________

To determine which factors were most important, I summed the responses for all the interviews for each factor and then ranked the factors based on that total.

The current flow regime and its impact on an angler's fishing trip was also a concern of VDGIF managers. To obtain this information, I asked anglers to choose from a range of "very satisfied" to "very dissatisfied" with the current flow patterns (Figure 8, question 10).

10.) How satisfied are you with the current flow patterns?

__very satisfied __ satisfied____ neutral___ dissatisfied ____very dissatisfied

a. **If not satisfied**, how could the situation be improved? ____________________

b. did you know the flow conditions before you came to fish today? yes____ no___

Philpott Reservoir

I conducted on-site interviews to gather data on Philpott Reservoir anglers, and grouped all anglers together during data analysis because I had no reason to believe differences existed between anglers in different parts of the reservoir. However, I thought there may be differences between anglers who fish the reservoir frequently, compared to those who don't. I separated anglers into two groups, "frequent" and "less frequent", using the average number of times all anglers had fished Philpott Reservoir in the last 12 months (average=28 times). Anglers who fished more than 28 times were "frequent" and those less than or equal to 28 were "less frequent". I then made comparisons between the two groups because I thought that anglers who fished Philpott Reservoir more often may have different characteristics than more casual anglers.

As was the case for the Smith River, I determined which factors influenced anglers to fish Philpott Reservoir. The factors are given in question 23 of the Philpott Reservoir angler interview form (Figure 9).

23.) Which factors were most important in your choosing to fish Philpott Reservoir today?

a.) opp. to catch lots of fish ____	e.) to test my fishing skills ____	i.) to view the scenery ____
b.) I've had success here before____	f.) for the solitude ____	j.) where my friends were going____
c.) close to home ____	g.) opp. to catch a trophy fish____	k.) to be with friends or family____
d.) to catch fish to eat ____	h.) less crowded than other places I fish ____	l.) opp. to catch ___species ____
		m.) other ____________

I also determined which management options anglers would like to see emphasized more in the future (Figure 9, Question 24).

24.) Please assign a number value to each of the following areas corresponding to level of management effort (**1=low effort, 5=high**).

a.) stocking	1	2	3	4	5
b.) water level management	1	2	3	4	5
c.) fishing regulations	1	2	3	4	5
d.) increased access (parking, trails, etc.)	1	2	3	4	5
e.) law enforcement	1	2	3	4	5
f.) fish habitat enhancement	1	2	3	4	5
g.) other ____________	1	2	3	4	5

- Which of the above management options is most important to you? (circle) None____

Stocking, water level management, regulations, increased access, increased enforcement, and habitat enhancement were the six management options anglers evaluated. I asked anglers to assign a value of 1-5 to each management option, a higher number corresponding to increased future effort in that area. I averaged all the responses for each management option then ranked them from highest to lowest to determine which were most important.

RESULTS

Smith River

All of the anglers I interviewed in the middle section of the river were wade fishing, and nearly all (91%) used fly fishing gear (Table 67). Forty-three percent of the anglers I interviewed in the middle section belonged to Trout Unlimited, compared to 9.5% in the upper section and 16% in the lower section. Anglers in the middle section also spent, on average, the longest time fishing of anglers in any of the three sections. Wading was also the most popular form of fishing in the upper and lower sections, however, the majority of anglers in these two sections used bait (52% , and 70%, respectively; Table 67). Anglers in the upper section fished the Smith River more times in the last twelve months (20) than anglers in the lower (19) and middle (12) sections.

Anglers in the middle section had the highest average total household income before taxes ($55,000-79,999; Table 67), and, on average, were the most educated, completing the equivalent of a Bachelor's degree. The majority of anglers I interviewed in the middle section lived out-of-state (53%), primarily in North Carolina. Anglers in the upper and lower sections were more likely to live in-state (93% and 85%, respectively).

Management Alternatives

Anglers in the upper and lower sections preferred to see most future management emphasize stocking, while anglers in the middle section favored management through regulations (Table 68). Increasing or improving access ranked lowest in all three river sections. Flow management was the second most popular management option to

Table 67. Descriptive statistics of angler characteristics for each section of the Smith River. Statistics were generated from data pooled for the entire study period. Values given are means unless otherwise specified.

	River section		
Angler characteristic	Upper	Middle	Lower
Party size	2	2	2
Fishing from shore (percent)	40	0	34
Wading (percent)	74	100	70
Bait angler (percent)	52	1.5	70
Lure angler (percent)	25	4.5	17
Fly angler (percent)	24	91	21
Hours spent fishing	3.6	4.6	3.0
Number caught (brown and rainbow)	3.19	3.49	2.11
Miles traveled to Smith River	40.5	82.8	24.0
# of times fished Smith River in last 12 months	20	12	19
% who knew bag limit	97	96	90
% who knew size limit	80	96	92
% who knew lure restrictions	94	96	90
Modal income category	<19,999	55,000-79,999	35,000-54,999
Highest educational level completed	13	16	13
Age	41	40	46
TU member (percent)	9.5	43	1.6
Percent residing instate	93	47	85

Table 68. Mean responses of anglers concerning five different management options. I asked anglers to assign a value of 1-5 to each management option, a higher number corresponding to increased future effort in that area

	River section		
Management area	Upper	Middle	Lower
Stocking	4.02	3.11	4.03
Flow management	3.05	3.23	3.08
Fishing regulations	3.19	4.06	3.51
Increased access	2.83	2.83	2.90

anglers in the middle section, but flow management rated second to last for anglers in the other two sections (Table 68).

Current Flow Patterns

A majority of anglers in all three river sections were satisfied with the current flow regime, with 65% of the anglers interviewed in the middle section and 66% of anglers in the upper section being either "very satisfied" or "satisfied" (Table 69). The highest proportion of anglers who were either "very dissatisfied" or "dissatisfied" was in the lower section, at 21%, followed by anglers in the middle and upper sections, both at 17% (Table 69).

Why Anglers Fish the Smith River

Anglers in the middle section overwhelmingly chose "the opportunity to catch wild trout" as the most important factor influencing their decision to fish the Smith River (Table 70). This factor was also one of the top five factors in the upper and lower sections. Anglers in the middle section also enjoyed the solitude and the chance to test their fishing skills. The Smith River being close to an angler's home was also one of the top five factors in each of the three river sections. Even though anglers in the middle section traveled a considerable distance, the Smith River's wild trout fishery was the closest of its kind to their home.

Philpott Reservoir

The overwhelming majority, 99.4%, of the anglers I interviewed fished from a boat, sought black bass (75%), and used artificial lures (87%; Table 71). Twenty-two percent of the anglers I interviewed during the summer period were fishing at night. I

Table 69. Percent of anglers who were satisfied with the current flow regime. I asked anglers if they were very satisfied, satisfied, neutral, dissatisfied, or very dissatisfied with current flow patterns.

	River section		
Satisfaction choice	Upper	Middle	Lower
Very satisfied	12	4	3
Satisfied	54	61	51
Neutral	18	19	26
Dissatisfied	14	15	21
Very dissatisfied	3	2	0

Table 70. Factors influencing an angler's decision to fish the Smith River. The numbers given represents the percent of anglers who chose each factor. Percentages do not total 100 because anglers could choose more than 1 factor.

Section	Factors
Upper	- opp. to catch lots of fish (38) - opp. to catch a trophy fish (35) - to test my fishing skills (35) - opp. to catch wild trout (27) - close to home (27)
Middle	- opp. to catch wild trout (54) - to test my fishing skills (25) - for the solitude (25) - opp. to catch a trophy fish (24) - close to home (24)
Lower	- close to home (42) - opp. to catch wild trout (27) - opp. to catch lots of fish (24) - to test my fishing skills (24) - for the solitude (24)

Table 71. Descriptive statistics of angler characteristics for Philpott Reservoir. Statistics were generated from data pooled for each sampling period. Values given are means unless otherwise specified.

Angler characteristic	Average
Party size	2
Boat angler (percent)	99.4
Bank angler (percent)	0.6
Fishing at night (summer season only)	22.0
Bait angler (percent)	32.0
Lure angler (percent)	87.0
Trolling (percent)	26.0
Hours spent fishing	4.75
Number caught - (all species)	4.17
Miles traveled to Philpott Reservoir (one-way)	22
# of times fished Philpott Reservoir in last 12 months	28
% who knew bass bag limit	65.0
% who knew bass size limit	75.0
% who knew walleye bag limit	11.0
% who knew trout bag limit	19.0
% who knew trout size limit	12.0
% who knew crappie bag limit	32.0
Modal income category	$35,000-54,999
Highest educational level completed	12
Age	42
Bass club member (percent)	18.0
Local club member (percent)	11.0
Percent residing instate	90.0

conducted additional interviews at night during the summer period to improve interview numbers. This figure does not include tournament anglers. Overall, anglers were familiar with fishing regulations related to black bass (the target species of most anglers), but were less familiar with other species, such as walleye, trout, and crappie. A relatively high proportion (18%) of anglers belonged to national fishing organizations, such as Bass Anglers Sportsman's Society (B.A.S.S), while 11% were members of local fishing clubs. Anglers I interviewed completed on average the equivalent of a high school diploma, and had a total combined household income before taxes between $35,0000 and $54,999 (Table 71). Ninety percent of the anglers resided in-state.

Management Alternatives

Anglers I interviewed favored stocking as highest priority for future management (Table 72). Increased access and enforcement were also ranked as high priority. Water level management was of least concern to anglers.

Why Anglers Fish Philpott Reservoir

Most of the anglers I interviewed fished Philpott Reservoir due to its close proximity to their homes. This factor received more than twice as many responses as the next closest factor, which is "I've had success here before" (Table 73). To "test my fishing skills" and "for the solitude" also were important factors influencing an angler's decision to fish Philpott Reservoir. "Where my friends were going" and the "opportunity to catch a specific species" were the factors least often chosen by anglers I interviewed.

Table 72. Mean responses of anglers concerning six different management options. I asked anglers to assign a value of 1-5 to each management option, a higher number corresponding to increased future effort in that area

Management Area	Average
Stocking	4.02
Water level management	2.33
Regulations	2.40
Increased access	3.09
Increased Enforcement	3.09
Habitat enhancement	2.83

Table 73. Factors influencing an angler's decision to fish Philpott Reservoir. Numbers represent percent of anglers who chose each factor. Percentages do not total 100 because anglers could choose more than one factor.

Factor	Total[a]
Close to home	64
I've had success here before	29
To test my fishing skills	26
For the solitude	22
Opportunity to catch lots of fish	21
To be with friends or family	20
To view the scenery	19
Less crowded than other places I fish	16
To catch fish to eat	13
Opportunity to catch a trophy fish	13
Where my friends were going	6
Opportunity to catch a certain species	5

[a]anglers could choose as many factors that influenced their decision to fish Philpott Reservoir the day I interviewed them.

Characteristics of Frequent and Less Frequent Anglers

"Frequent" and "less frequent" anglers shared many characteristics, including percentage of boat anglers, hours spent fishing, income, and educational level (Table 74). There were, however some interesting differences. For example, a higher proportion of "frequent" anglers used lures and fished Philpott Reservoir on average of 45 times more in the last year than "less frequent" anglers. "Less frequent" anglers were more likely to be using bait and trolling, compared to "frequent" anglers. Even though both angler types spent about the same time fishing, "frequent" anglers caught roughly 2.5 times more fish than "less frequent" anglers. "Frequent" anglers were also more likely to be targeting black bass (80%) compared to only 65% of "less frequent" anglers (Table 74). Roughly twice as many "frequent" anglers were members of national or local fishing clubs. Thirty five percent of Philpott Reservoir anglers I interviewed were "frequent" anglers, and 65% were "nonfrequent anglers". Tournament anglers were not included in either the "frequent" or "less frequent" group.

Management alternatives

Both "frequent" and "less frequent anglers both felt stocking should be highly emphasized during future management of Philpott Reservoir (Table 75). "Frequent" anglers then desired increased enforcement and access, while "less frequent" anglers wanted more emphasis placed on habitat improvement. Water level management was rated lowest by both angler groups (Table 75).

Why anglers fish Philpott Reservoir

Both angler groups were similar in that they chose "close to home" as their number one reason for fishing Philpott Reservoir (Table 76). "I've had success here

Table 74. Descriptive statistics for "frequent" and "infrequent" anglers on Philpott Reservoir. Frequent anglers are those who have fished Philpott more than 28 times in the last twelve months, which is the average of all anglers. Values given are means unless otherwise specified.

Angler characteristic	Frequent	Infrequent
Party size	2	2
Boat angler (percent)	100	99.0
Bank angler (percent)	0	1.0
Fishing at night (summer season only)(percent)	9.5	13.0
Bait angler (percent)	27.0	36.0
Lure angler (percent)	93.0	82.0
Trolling (percent)	20	31.0
Hours spent fishing	4.85	4.68
Number caught - (all species)	5.62	3.00
Miles traveled to Philpott Reservoir (one-way)	14.42	26.3
# of times fished Philpott Reservoir in last 12 months	56.92	11.91
% who knew bass bag limit	78.0	58.0
% who knew bass size limit	83.0	70.0
% who knew walleye bag limit	17.0	8.0
% who knew trout bag limit	41.0	7.0
% who knew trout size limit	25.0	4.0
% who knew crappie bag limit	46.0	25.0
Modal income category	$35,000-54,999	$35,000-54,999
Highest educational level completed	12.02	12.51
Age	41.8	41.4
Bass club member (percent)	23.0	14.4
Local club member (percent)	15.0	7.8
Percent residing instate	98.0	85.0

Table 75. Mean responses of "frequent" and "infrequent" anglers concerning six different management options. I asked anglers to assign a value of 1-5 to each management option, a higher number corresponding to increased future effort in that area

Management Area	Frequent	Infrequent
Stocking	4.02 (1)	4.02 (1)
Water level management	2.08 (5)	2.49 (6)
Regulations	2.08 (6)	2.59 (5)
Increased access	3.42 (3)	2.88 (2)
Increased Enforcement	3.44 (2)	2.87 (4)
Habitat enhancement	2.78 (4)	2.86 (3)

Table 76. Factors influencing an angler's decision to fish Philpott Reservoir. Percentages do not total 100 because anglers could choose more than 1 factor. The number given in parentheses is the factor's rank.

Factor	Frequent	Infrequent
Close to home	79 (1)	65 (1)
I've had success here before	35 (3)	30 (2)
To test my fishing skills	39 (2)	23 (5)
For the solitude	21 (5)	25 (4)
Opportunity to catch lots of fish	25 (4)	22 (6)
To be with friends or family	14 (7)	26 (3)
To view the scenery	19 (6)	22 (6)
Less crowded than other places I fish	12 (8)	21 (7)
To catch fish to eat	14 (7)	14 (8)
Opportunity to catch a trophy fish	19 (6)	11 (9)
Where my friends were going	14 (6)	3 (10)
Opportunity to catch a certain species	12 (8)	2 (11)

before", and "for the solitude" were also important to both angler groups. Less frequent anglers were more likely to choose factors such as "to be with friends or family", and "less crowded than other places I fish", as their reasons for fishing Philpott Reservoir. "Frequent" anglers chose to fish Philpott Reservoir to target a specific species (12%) , and for the opportunity to catch a trophy fish (19%) Thirty nine percent of "frequent" anglers chose to fish Philpott Reservoir to test their fishing skills, compared to only 23% of less frequent anglers. Both groups had the same number of responses to the factor "to catch fish to eat" (14%; Table 76).

DISCUSSION

Smith River

Anglers differed distinctly among river sections. Anglers in the upper and lower section were somewhat similar to each other, while anglers in the middle section differed. In the following section, I profile the characteristics of typical anglers in each river section.

Upper section

Anglers in the upper section generally waded while fishing with bait and usually knew the fishing regulations. They had low income levels and moderate educational levels, generally resided in-state and were not members of Trout Unlimited. Their preferred management emphasis was stocking and they tended to be satisfied with the current flow regime. They fished the Smith River primarily for the opportunity to catch lots of fish, big fish, and because it was close to home.

Middle section

Anglers in the middle section generally waded while fishing using fly fishing gear, and were very familiar with fishing regulations. They had high income and educational levels, and were likely to be members of Trout Unlimited who resided out-of-state. Their preferred future management emphasis was fishing regulations and they generally were satisfied with the current flow regime. Anglers in the middle section fished the Smith River primarily for the opportunity to catch wild trout, to test their fishing skills, and for the solitude.

Lower section

Anglers in the lower section generally waded while fishing with bait and were fairly familiar with fishing regulations. They had moderate-income levels, low educational levels, and only about one out of six were members of Trout Unlimited. The majority of lower section anglers resided in state and preferred future management efforts to be directed toward stocking. They tended to be satisfied with the current flow regime and to fish the Smith River because it was close to their home, to catch lots of fish, and to catch wild trout. However, the desire to catch wild trout is inconsistent with many of the other characteristics other lower section anglers (favor stocking, fish to catch a lot of fish, high harvest rate, etc.).

Angler Specialization

I have suggested that anglers in the middle section are different than anglers in the upper section and lower section in their management preferences, reasons for fishing the Smith River, and gear type preferences. Many of these differences in characteristics relate back to the nature of the river sections themselves. The upper section, with its many access points, provides a relatively undisturbed fishing environment where anglers can catch brown trout and stocked rainbow trout. The middle section, with its limited access and more stringent fishing regulations, also provides a quiet fishing environment in which anglers catch and fish almost exclusively for wild brown trout. The lower section, which is lined with commercial and industrial property, provides easy access to local anglers fishing for stocked rainbow trout, and the occasional brown trout. As the river itself changes as it flows downstream, so do the characteristics and level of specialization of the anglers who fish the river.

Bryan (1977) suggested that recreational specialization can be referred to as a continuum of behavior from the general to those who seek specific experiences from a recreational activity. He applied this theory to trout anglers by conducting on-site interviews on trout waters in Wyoming, Montana and Idaho. He also spent time watching anglers as they fished to determine skill level and techniques used by anglers. As a result of the on-site interviews and observations, anglers were grouped into 4 categories: (1) occasional fisherman, who were new to the sport and fished infrequently; (2) generalists, who used a variety of techniques and who used fishing as a regular leisure activity; (3) technique specialists, who fished almost exclusively using one particular method; and (4) technique-setting specialists, who were heavily committed to fishing and preferred to fish on specific types of water using one particular method. Bryan (1977) further characterized technique-setting specialists by the gear they used, which was often expensive fly fishing gear, such as custom made bamboo or graphite rods. Technique-setting specialists were also characterized by what they did not carry with them when they fish. For example, he observed very few anglers carrying landing nets or creels, since anglers rarely harvested fish they caught.

The characteristics and behavior of technique-setting specialists described by Bryan (1977) are similar to those exhibited by anglers who fished in the middle section of the Smith River. I did not observe any anglers fishing in the middle section without fly fishing gear. Most anglers began by putting something on the ground to stand on, carefully putting on all their gear, putting rods and reels together. Generally their gear preferences were the most expensive, starting with the typical Jeep Cherokee vehicle, followed by tight fitting neoprene waders, wading boots, bamboo or graphite fly rod, and the occasional cellular phone. Anglers chose to fish in the middle section of the Smith River because of the opportunity to catch wild, more elusive brown trout compared to stocked rainbow trout. Once fishing, I observed many anglers wading around looking for fish, or looking for just the right spot to fish in.

Anglers in the upper section and lower section were typical of occasional anglers, or generalists as described by Bryan (1977). On the opening day of trout season, many of the anglers I and VDGIF personnel interviewed fit into the occasional angler category. For some anglers, opening day was the only, or one of few, days they fished the entire year. Anglers in the upper section and lower section typically fished using whatever method was easiest and/or produced the most fish, which was an important component of a fishing trip to anglers in these sections. Stocking ranked as the most important future management action to anglers in the upper section and lower section, while anglers in the middle section preferred fishing regulations, further illustrating differences in angler characteristics between sections.

Chipman and Helfrich (1988) also explored the idea of recreational specialization of anglers who fished rivers in Virginia. They used on-site and mail surveys to assess specialization based on four dimensions of angler behavior: (1) resource use (equipment, water type, target species, frequency, use of bait, harvest), (2) experience (frequency and years angling), (3) investment (equipment, money), and (4) importance of fishing in an angler's life (membership in fishing clubs, travel distance, fishing vacations, etc.). Using multivariate cluster analysis, they identified six types of angler specialization from low to high, which partitioned anglers further than Bryan's (1977) four levels of specialization. Chipman and Helfrich partitioned anglers into the following categories: (1) occasional, characterized by low experience levels; (2) generalists, who had considerably more experience than occasional anglers; (3) experienced generalists, who were highly experienced with moderate investment, low in resource use; (4) committed generalists, who showed high levels of investment, and moderate resource use and experience; (5)

specialists, frequent anglers to whom resource use is very important, and (6) advanced specialists, who rated high in each of the four dimensions. Anglers in the middle section of the Smith River fit into Chipman and Helfrich's (1988) "advanced specialist" category. These anglers make considerable time and money investments traveling to the Smith River to fish, as I described in Chapter 2. They also usually have top of the line equipment, prefer wild trout, and were most likely of anglers in any of the three sections to be a member of a fishing organization such as Trout Unlimited or Fly Fishing Federation. Anglers who fished the upper section of the Smith River did not fit into one distinctive category. I interviewed anglers who fit into the "occasional", "generalist" and "experienced generalist" categories. Most of the anglers in this section were fishing with bait, however some would use lures and occasionally fly gear. Anglers in the lower section fit into the "occasional" or "generalist" categories. Due to the prominence of textile and furniture mills in the lower section, some anglers would go to the river to fish after work, using live bait or corn. They harvested 92% of the rainbow trout that they caught, the highest harvest rate of any river section.

In addition to determining whether members or nonmembers of national fishing organizations were in favor of or opposed to a catch-and-release regulation, Gigliotti and Peyton (1993) also used the "member" "nonmember" division to characterize anglers in other ways. For example, they found that members were almost twice as likely to release fish they caught, and also were more likely to fish using fly gear and to tie their own flies. Members also reported fishing for trout in streams is a more central type of recreational activity compared to nonmembers.

The Smith River provides different types on angling experiences within the 23 km I studied. The upper section contains pristine and quiet fishing areas where rainbow trout are stocked. The middle section offers wild, brown trout targeted by highly specialized anglers, while the lower section offers stocked rainbow trout targeted by the least specialized anglers looking to catch fish to harvest.

Angler Characteristics

Angler characteristics should be taken into consideration when future management decisions are made. Some anglers proposed expansion of the special regulations section of the Smith River. Such an expansion would increase the net economic value of the trout fishery, however, it would come at the expense of displacement of anglers in the upper and lower section. Out-of-state anglers with different characteristics would replace local anglers in the upper and lower sections.

Understanding differences in anglers' characteristics and level of specialization can also be of use when making management decisions. Gigliotti and Peyton (1993) used angler characteristics and their relationship to management preferences to determine differences in opinion towards a proposed catch-and-release regulation on a popular Michigan trout water, the Au Sable River. They grouped anglers into two groups, those that belonged to TU and/or FFF (trout angling specialists), and those that did not. Over one-half of the anglers they surveyed on the Au Sable River were members of a fishing organization. Not surprisingly, almost twice as many members of fishing organizations supported the catch-and-release proposal compared to nonmembers. The VDGIF would face a similar situation if more special regulation waters were made available on the Smith River. Anglers in the middle section, typically fly anglers and often TU members, would support such a management plan, whereas local, less specialized anglers would more than likely oppose such a proposition. In making a decision such as expanding the special regulations area, managers will be faced with the task of considering all the users (local residents, non-residents), their levels of specialization, and then allocating the resource fairly.

Anglers in the upper and lower sections overwhelmingly favored stocking as a tool for future management of the Smith River, whereas anglers in the middle section preferred wild trout management. Not surprisingly, anglers in the upper and lower sections responded that "catching lots of fish" was important to them, whereas anglers in the middle section preferred to test their fishing skills by using fly fishing gear and targeting fewer but larger wild trout. Anglers in the middle section preferred the least amount of future management effort in the area of increased access. During on-site interviews, many anglers expressed how crowded the middle section currently is with limited access. A more accessible section may lead to a more crowded fishery. Currently, most access to the section is gained from a single point at the upper end. Although access is available at the lower end, the fish habitat is not as good there. While conducting on-site interviews, I encountered a few anglers in the upper section who were fishing there because they did not know where the special regulations section was located. The section is not marked, and parking is somewhat confusing because it is permitted by a furniture company that owns property near the river. To an angler who has never fished the Smith River before, it would appear that parking on this lot would be trespassing.

Overall, anglers were satisfied with the current flow regime. This may be a result of anglers knowing the days flow pattern before they leave to go fishing, or that they fear future flow related changes may make fishing conditions worse. Anglers seem to be used to the system. Since anglers in the upper and lower sections don't travel far to the river, and don't make a great time or expense investment to fish the river, flow issues are not as important. If generation occurs during a fishing trip, they generally will have a short drive home. This is not the case for anglers in the middle section, who travel considerably farther distances to fish the river. For this reason, I would have expected anglers in the middle section to have a more vocal opinion of the current flow regime. Although anglers in all sections were satisfied with the somewhat predictable flow regime, the importance of flows became apparent observing angler use patterns in the middle section. I estimated angler use in the middle section on weekend days (when no generation occurs) to be seven times higher than effort during the week. Thus, anglers rarely fish in the middle section during the week, even though anglers responded they were satisfied with the current flow regime.

Philpott Reservoir

The typical angler fishing Philpott Reservoir targeted black bass, (primarily largemouth bass), fished from a boat, used artificial lures, and had fished the reservoir an average of 28 times in the last twelve months. I did not interview any anglers who were fishing for walleye or trout. I underestimated the impact bank anglers may have on the fishery because it was difficult to obtain interviews. Many of the areas I observed anglers fishing from shore did not have an adequate boat landing area. For that reason, almost all the interviews were conducted at boat ramps with anglers as they completed their trip. Most of the bank fishing took place at the campgrounds scattered around the reservoir. Many of the anglers I interviewed also were members of fishing clubs and took part in regular summer tournaments.

Most reservoir anglers were concerned with how many fish they were catching. Many anglers complained that it has become increasingly difficult to catch many fish at Philpott Reservoir, compared to the past. This may explain their preference for future management efforts in stocking. Anglers also expressed their concerns about the lack of enforcement presence and responded favorably towards increased efforts in this area. Access was also an area anglers wished to see improved. Many of the boat ramps and parking areas filled quickly on busy summer weekends. The most popular ramp, located close to Philpott Dam, often filled completely on busy weekends and holidays.

Even though some anglers perceived a decline in the fishery, many chose to fish Philpott Reservoir because "they've had success here before". The reservoir's close location to many of the anglers' homes was an important factor. Philpott Reservoir provides a somewhat unique opportunity in that almost all of its shoreline is undeveloped. This differs drastically from other reservoirs in the area, such as Smith Mountain Lake. Anglers also chose "for the solitude" as a very important factor in influencing them to fish Philpott reservoir.

Frequent and Less Frequent Anglers

"Frequent" and "less frequent" anglers differed in their reasons and approach to fishing, as well as in their characteristics. "Frequent" anglers appeared to be more serious and knowledgeable about fishing, which may contribute to their higher catch rate per hour (1.16 fish/hr) compared to "less frequent" anglers (0.64 fish/hr). The typical "frequent" angler targeted black bass and due to their increased involvement in fishing, were more likely to be members of fishing organizations.

Management alternatives

For both "frequent" and "less frequent" anglers catching many fish was an important component of a quality fishing trip. Both groups chose stocking as the area where the most future management effort is needed. Stocking appears to be a quick way to improve the number of fish being caught. Many anglers also expressed concern about the lack of enforcement on the reservoir. Most of the concerns were not about enforcement of fishing regulations, but general safety concerns, such as drinking, reckless boating, and personal watercraft operators jumping wakes and following too closely. Some anglers were concerned about the impact of fishing tournaments on the bass population.

Why anglers fish Philpott Reservoir

The close proximity of Philpott Reservoir to anglers' homes was the main reason anglers chose to fish. In general, anglers did not travel as far to Philpott Reservoir as they did to the Smith River. "Less frequent" anglers seemed to fish for more social reasons, such as being with friends or family, than did "frequent" anglers. These anglers also were more likely to use fishing techniques such as trolling or fishing with live bait. "Frequent" anglers fished to test their skills using different techniques to catch black bass.

CONCLUSIONS AND MANAGEMENT RECOMMENDATIONS

1. The total economic value of the Smith River and Philpott Reservoir fisheries ($656,140; CVM estimate) was nearly equal to the value of power produced at Philpott Dam during fiscal year 1995 ($669,375).

The CVM estimate of consumer surplus is based on current use of the river and willingness to pay values supplied by anglers I interviewed. Under the current power generation schedule, 88% occurred on weekend days in the middle section. During the summer season, weekend day effort comprised 98% of total summer effort. Angler use patterns were directly influenced by the weekday-only generation schedule. Modifying peaking flows to allow weekday fishing would attract more anglers to the middle section, increasing weekday effort. If angler effort in the middle section on weekdays were increased to 50% of effort on weekend days, it would result in a 32% increase in total economic value of the entire river fishery. This does not take into account the additional economic increases that would result as more large and wild trout are produced from a modified flow regime.

The drawback of reducing peaking flows at Philpott Dam is revenue loss. The Southeastern Power Administration markets power to municipalities across the Southeast which then sell the power to local customers. Because the power produced at Philpott Dam is distributed all across the Southeast to different customers, the losses in revenues would also be spread out and shared by all those who receive power from Philpott Dam. However the benefits from a reduction in peaking operation (e.g., more fishing opportunities, better trout habitat, increased consumer surplus, increase in angler expenditures in local economy) would occur locally. The difference between the value of both the Smith River and Philpott Reservoir fisheries and the value of power was only $13,235, i.e., the total value of both fisheries under existing conditions was essentially equal to the value of power produced. The revenue losses that would be incurred if peaking was reduced are currently unknown, however it is likely that they would be offset by increases in economic value of the fishery. If the operation of Philpott Dam was changed, losses in revenues may be minor, depending on the type of flow regime implemented. The optimum operation of Philpott Dam would be to enhance the fishery while at the same time considering power revenues. The final mode of operation may lead to only minor losses in revenues, but large gains in economic value of the fishery.

2. Philpott Dam should be altered to provide higher base flows.

There is great potential to improve the trout fishery in the Smith River by minimizing peaking flows and providing higher minimum flows. Such a flow regime would enhance the existing trout fishery and likely produce more large trout. Anglers in all three river sections were willing to pay the most of any fishing scenario for an increased chance of catching a large trout (> 16 in.). The total economic value of the fishery under current conditions ($440,571) increased by 31% to $634,345 under the large trout scenario, which is only $35,050 less than the value of power produced at Philpott Dam during fiscal year 1995 ($669,375). Philpott Dam is currently operated in a peaking mode, producing power in response to demand for electrical energy. This type of operation maximizes revenues from the sale of electrical energy. Conversely, my estimate of total economic value of the fishery is a minimum value based on the fishery under current conditions (flow regime, use patterns). Eliminating severe flow fluctuations and providing higher minimum flows would promote the production of more large trout and wild trout, which were the two fishing scenarios that had the highest total economic values. As more and larger fish are available for anglers to catch, total economic value of the fishery would and larger fish are available for anglers to catch, total economic value of the fishery would increase as well, as I have already shown. Numbers of large trout and wild trout should increase considerably under a nonpeaking mode of operationleading to increased consumer surplus that would likely offset losses from decreased power value. Economic value would increase even further than I have shown because my estimates are based on current use levels, which would increase if anglers could fish the river at any time (weekdays) without the risk of high flows.

The Smith River should be managed to produce more trout larger than 16 in., which would satisfy anglers who fish the river and considerably increase the total economic value of the fishery. Further studies are needed to determine what flow levels would best benefit the trout fishery and to evaluate current and future trout habitat needs. Using the economic figures from the CVM, managers can compare benefits recognized by anglers to the costs of implementing a management program. Virginia Department of Game and Inland Fishery managers also can use the CVM estimates to evaluate the cost/benefit of the existing stocking program. It appears anglers are receiving a high benefit relative to the costs associated with stocking trout.

3. Expanding the special regulations section would increase total economic value.

The economic value of the trout fishery in the middle section of the river is high relative to the length of the section. Expanding the special regulations section, if it were deemed desirable by VDGIF managers, would attract more anglers and provide them with more fishing areas. Based on the characteristics of anglers who fish the middle section of the river, and their motivation for fishing, expansion of the special regulations section should be upstream. The lower section of the Smith River does not provide the environment that the highly specialized, wild trout seeking anglers in the middle section desire. The upper section of the river has similar characteristics of the middle section. However, anglers who fish the upper section are almost exclusively local, in-state residents, while the majority of anglers in the middle section travel considerable distances from outside the state of Virginia. Conflict may result as local anglers, who fish primarily to catch stocked rainbow trout and favor increased future stocking, would be displaced by an enlarged special regulations section.

4. Virginia Department of Game and Inland Fisheries should reevaluate their current stocking policy for Philpott Reservoir to determine if the benefits provided to anglers from stocking trout and walleye outweigh the costs of the stocking program

During the study period I did not interview any anglers who were targeting these species. The trout fishing scenario was the only scenario valued by anglers less than the fishery under current conditions, which shows a general lack of interest by anglers in fishing for trout. Stocking efforts may better benefit the fishery if directed towards more popular species. There is potential to improve the walleye fishery, which anglers did show some interest in and valued 15% higher than the fishery under current conditions. Although I did not interview any anglers who were targeting walleye, some did express an interest to me in catching them and learning techniques to improve their success rate. Improving the fishery should involve increasing public awareness of the fishery and common techniques used to effectively catch them.

5. Future management of the highly nonconsumptive Philpott Reservoir black bass fishery should be directed towards providing anglers with a chance of catching more fish, rather that managing for large fish or a trophy fishery.

Seventy-five percent of the anglers I interviewed targeted black bass, and the value of the fishery increased by 41% for the increased chance of catching a black bass. Anglers also overwhelmingly favored stocking as a future management option to improve the bass fishery in Philpott Reservoir. The opportunity to catch lots of fish was more of a motivational factor for anglers to fish Philpott Reservoir than was the chance to catch a trophy fish. While catching large fish is important to most anglers, a successful fishing trip to the majority of Philpott Anglers meant catching many fish. Many anglers I interviewed felt that it had become increasingly difficult to catch black bass, even though overall bass catch rates were higher in 1995 than in 1981.

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VITA

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